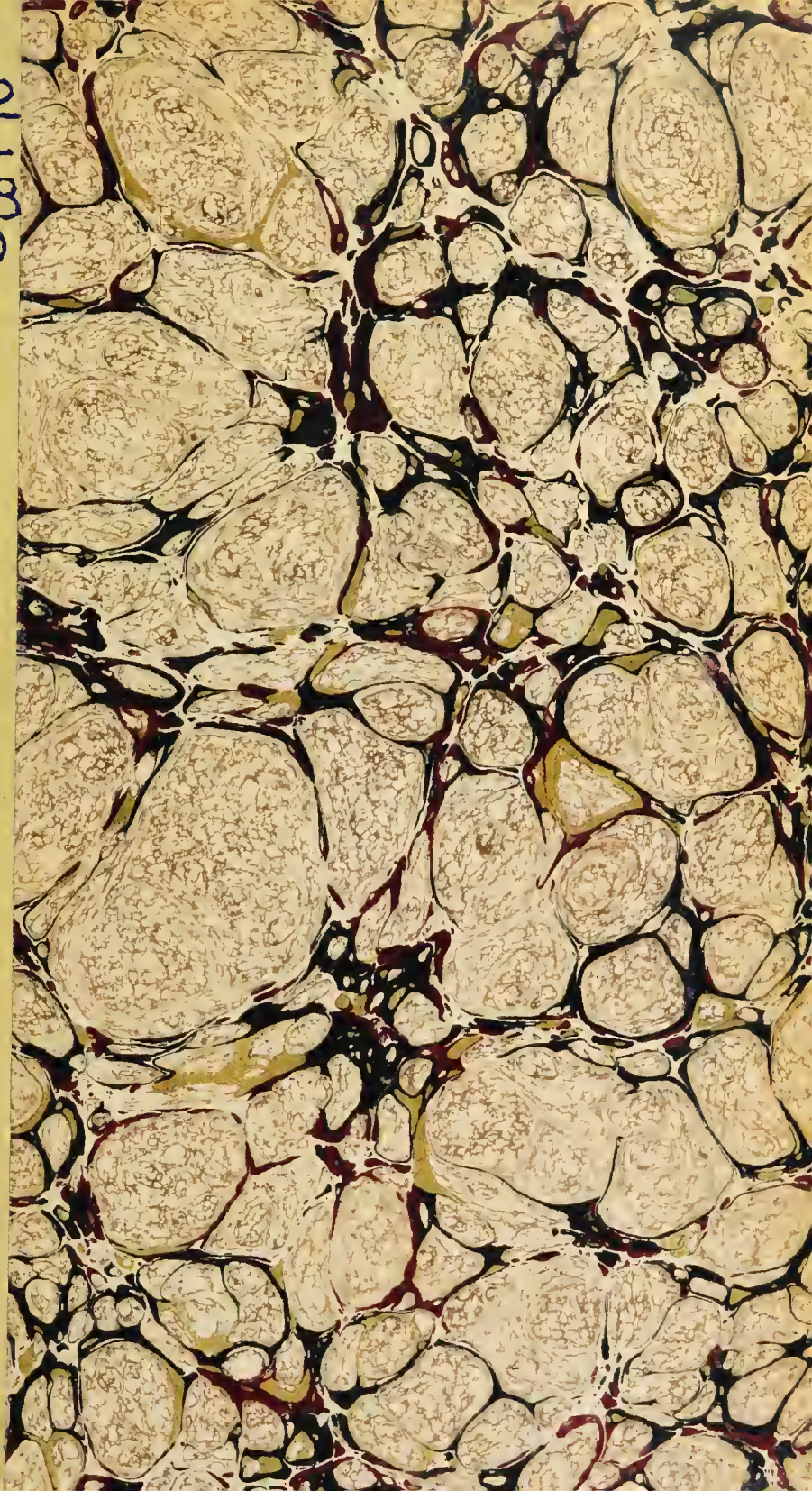


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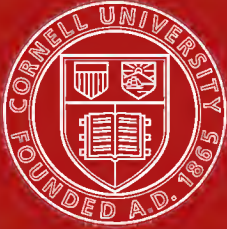
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MEMOIRS OF THE GEOLOGICAL SURVEY.

ENGLAND AND WALES.

EXPLANATION OF SHEET 300.

THE GEOLOGY OF THE COUNTRY AROUND ALRESFORD.

BY

H. J. OSBORNE WHITE, F.G.S.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HIS MAJESTY'S TREASURY.



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MEMOIRS OF THE GEOLOGICAL SURVEY.

ENGLAND AND WALES.

EXPLANATION OF SHEET 300.

THE GEOLOGY OF THE COUNTRY AROUND ALRESFORD.

BY

H. J. OSBORNE WHITE, F.G.S.

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PREFACE.

The area covered by the New Series Sheet 300, which is described in this Memoir, was originally surveyed on the Old Series one-inch maps Sheets 8, 9, 11 and 12 by H. W. Bristow, F. Drew and T. R. Polwhele, and the geological information was published during the years 1858–1868. It was re-surveyed on the six-inch scale by C. E. Hawkins, and the New Series Sheet, founded on the re-survey, was published as a hand-coloured map in 1898, and in the colour-printed edition in 1905.

A part of the area was briefly described in 1862 by H. W. Bristow and W. Whitaker, in their Memoir on Parts of Berkshire and Hampshire (Sheet 12), and in 1875 by W. Topley, in the Memoir on the Geology of the Weald. Some observations on the Upper Cretaceous Rocks were incorporated by A. J. Jukes-Browne in the General Memoir on the Cretaceous Rocks of Britain (1900–1904), but no detailed account of the geology of Sheet 300 has before appeared.

Mr. H. J. Osborne White, who has written the Memoirs on some of the adjacent Sheets, and was already well acquainted with the district here described, has re-examined the principal sections for the purposes of this Memoir. The observations thus made have enabled him to bring the geology of the region into accordance with the most recent zonal work, while at the same time he has incorporated the results of his researches on such questions as the tectonic structure and the distribution of superficial deposits.

He desires to acknowledge assistance received from Dr. A. W. Rowe, Mr. Ll. Treacher, Mr. C. Griffith, and Mr. A. S. Kennard.

J. J. H. TEALL,
Director.

Geological Survey Office,
28, Jermyn Street,
2nd June, 1910.

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THE GEOLOGY OF THE COUNTRY AROUND **ALRESFORD.**

CHAPTER I. INTRODUCTION.

Area.—The country represented on the Alresford Sheet (No. 300) of the Geological Survey Map has an area of 216 square miles, of which approximately 209 are in the eastern part of Hampshire, and the remainder in the north-western angle of Sussex. It includes the towns of Alton, Petersfield, and New Alresford; with Selborne, Lyss, Ropley, and West Meon among the larger villages.

The district is devoted mainly to agriculture, and is but thinly populated in its north-western and south-western parts. On the east, permanent military camps have been lately established at Bordon and Longmoor, in the Woolmer Forest area, and the wooded slopes about Sheet and Rake, near Petersfield, are being developed for residential purposes.*

Physical Features.—The country is conveniently divisible into three roughly north-and-south belts, of unequal width, and comprising, (1) the Chalk country, which occupies nearly three-fourths of the whole area, on the west, (2) the narrow, terrace-like tract on the Malmstone (Upper Greensand), between Binsted and Langrish, and (3) the sandy ground on the Lower Cretaceous rocks, with its border of clay land on the Gault, to the east. In describing their principal features it will be convenient to deal with their streams in a separate section.

1. The Chalk country has a prevailing westward slope, and ranges in altitude from 812 feet O.D. at Wheatham Hill, north of Petersfield, to 140 feet in the Itchen Valley, near Itchen Abbas. Its natural, eastern limit is marked by an escarpment, which presents two dissimilar facies respectively to the north and to the south of Selborne. Northward of that village it has a subdued and mature character, and is deeply indented by combes which tend, by

* Owing to the construction of new lines of railway, and to the creation or expansion of settlements in recent years, the topography of Sheet 300 of the One-inch Ordnance Map used for the current (1905) colour-printed geological edition already stands much in need of revision. Besides the four branch-lines of the London and South-Western Railway, which appear on this sheet, there now exist, (1) the Meon Valley Branch, running from The Butts junction south-west of Alton, by Lower Faringdon, East Tisted, Privett, and West Meon, and (2) the Bordon Light Railway, running from Bentley Station (Sheet 284), by Blacknest and Kingsley, to the Camps of Bordon (south of Broxhead Common) and Longmoor (east of Greatham).

their number and oblique arrangement, to weaken its frontal aspect. The range of low, detached hills between Alton and Faringdon also helps to make this part of the escarpment unimpressive when viewed from the east.

On the upland promontory above Selborne the scarp abruptly assumes a bold character, with a descent of 200 feet, at an angle of 20° to 30° , from the verge of Selborne Common to the foot of the Hanger on the south-western outskirts of the village. On the eastern salient and flat southern flank of Noar Hill the scarp is still steeper, and thence southward, it maintains its bold expression, round a pleasing succession of embayments and wooded headlands, to the boundary of the district, near Langrish.

The highest grounds in the Chalk country lie at or near the upper edge of this escarpment, whence the upland surface falls away, at a low angle, towards the west. For a breadth of one to five miles westward of the crest-line the country has the character of an inclined plateau, well dissected by rather bluntly-incised valleys which, in some cases, run back to gaps in the escarpment. This upland area includes the greater part of the so-called Alton Hills. The principal villages are Bentworth, Medsted (or Medstead), Colemore, East and West Tisted, Privett, and Froxfield; all, save East Tisted, standing on the flat-topped or rounded spurs between the valleys.

Farther west the upland divides into three principal, roughly east-and-west and convergent ridges. Of these, one extends from West Tisted to Tichborne Down, near Alresford; the second and third, respectively to the north and to the south of the first, are traceable for some miles beyond the western limit of the present district. The second or northern ridge runs from the neighbourhood of Wield, near Medsted, through Juniper and Bogmoor Hills, to Swarraton, where it is breached by the Candover Stream, west of which it continues through Grange Park and Itchen Wood. The southern ridge, which forms much of the south-western part of the district, is wider and more complex than the rest. Viewed lengthwise, it has a broadly-terraced appearance; the higher part, with a crest-line running north-westward from Wheely Down (near Warnford), by Lane End Down and Cheesefoot Head, being flanked on the north-east by the step-feature which supports Kilnston, Beauworth, and Hampage Wood, and which is continued eastward in the partly detached ridge of Old Down and Bereleigh House, north of the Meon Valley.

The northernmost of the four vales parted by the ridges above described contains the Candover villages, and East and West Stratton; and is cut in two by a low, transverse ridge that rises from the right bank of the Candover Stream. Old and New Alresford, Bishop's Sutton, Ropley, and Itchen Abbas lie in the wider depression next to the south; and Bramdean, Cheriton, and Tichborne, in the valley of the Upper Itchen and Bramdean Bottom. The fourth and southernmost area of relatively low ground is of irregular form, and includes the section of the Meon Valley between Drayton Mill and Warnford, and the slopes about Baybridge.

2. The second belt, above identified, for the sake of brevity, with the area of the Malmstone outcrop, includes also a small and comparatively low-lying portion of the Chalk country, situated to the north-west of Selborne.

The eastern border of this belt, like that of the last, is an escarpment, generally steep, and in places (as near Hawkley) even precipitous. The scarp has a height of between 50 and 200 feet, and is much broken by landslips, which will be noticed on a later page.

The width of the tract now under consideration decreases southward, from about four miles near Binsted to one mile near Selborne, and a quarter of a mile, or less, at Ridge Common, beyond which place it expands to about one mile, near Langrish. As in the case of the Chalk upland, the country here declines gently westward from the upper edge or crest of the escarpment, and thus forms, in its broader parts, one side and much of the floor of an open vale, overlooked by the higher ground of the Alton Hills to the west.

This vale is best developed to the east of Faringdon and Chawton, its bottom there being a grassy plain about a mile wide from east to west. Northward, near Alton, it is broken by low chalk-hills rising from the right bank of the Wey, and its place as the dominant feature of this division of the district is taken by the plateau-promontory of Binsted. Southward, the vale narrows rapidly, and takes the form of a roughly-aligned succession of shallow depressions, following the curved foot of the Chalk escarpment, and leading into sharply-cut gorges of considerable beauty, which descend eastward against the general inclination of the ground, and trench the Malmstone terrace from side to side.

3. The country in the eastern division of the district has characteristics markedly different from those of the two areas first described.

Parallel with the western border of the Malmstone terrace there extends a belt of grass and woodland, having a width of one quarter to one and a half miles, and a prevailing eastward slope, which, while frequently steep and broken by landslips along the foot of the Malmstone scarp, is usually of moderate or gentle inclination in its lower parts.

Here, on the Gault clays, there are several farms and some small hamlets, but settlements of larger size (such as those at Stroud and Steep Commons) are scarce, and mainly of recent date.

Eastward, the clay country passes, without abrupt change of contour, into a sandy tract, bearing broad stretches of heath interspersed with woods or plantations of conifers, and enlivened near its western border by numerous brooks and shallow, lake-like ponds. A line of villages — Kingsley, Oakhanger, Blackmoor, Greatham, and Lyss—follows the moist margin of the sands, on the west: Petersfield and Rogate carry on the line near the southern limit of the district.

Farther within the sandy tract the ground rises eastward into two low hill-ranges, separated by the valley which is followed by the Portsmouth Direct Railway east of Lyss. The Woolmer Forest range, north of this railway, has a relief of 100 to 150 feet ;

its contours, for the most part, are of bluntly rounded form, but assume a broken and even a bold character in Weaver's Down. Here the range presents a steep face to the south-east; and a similar scarp, at the edge of Broxhead Common, overlooks the low-lying marshy ground near Lindford, in the valley of the Dead-water. Strewn with fluted and flaggy pieces of carstone, and but sparsely patched with heath vegetation, the slopes of Weaver's Down have an aspect of sterility not often surpassed in the south-east of England.

The southern mass of comparatively high ground, supporting the woods and commons of Rogate and Rake, is the V-shaped south-western extremity of the range that includes Blackdown and Hindhead, in Surrey. The external slopes—north, west, and south—are of moderate inclination, and though furrowed by combs are nowhere deeply dissected: the inner slopes are steep and indented, and afford a quick descent, of 250 feet, from the crest of the range to the uneven, marshy floor of Harting Combe.

Rivers.—The water-parting between the Thames drainage-system and the streams which run to the English Channel traverses the Alresford district by a tortuous path, keeping mainly to high ground. Entering this area near Bradley, on the north, it follows the top of the ridge to the east of that village, by the Wilds, Heath Green, and Hattingley to Medsted, whence it runs southward, through Lyeway, Charlwood, and West Tisted, to Filmore Hill.

From Filmore Hill it trends eastwards, by Hurst and Bydean Farms north of Froxfield, to the summit of Stoner Hill, from which spot it strikes northward, across ridge and valley, by Warren Corner and Goleigh Farm, to the top of Noar Hill. Quitting the Chalk country north-east of Noar Hill, it curves north-east and eastward, by Temple Farm, and, passing just south of Woolmer Pond, runs over Weaver's Down, to the eastern limit of the district.

The country east and north of this divide is in the Wey catchment of the Thames basin.

The North or Farnham Branch of the Wey, with head-springs near Will Hall, flows through Alton north-eastward, by Holybourne and Mill Court. Its chief local affluent is the Caker Stream, which has a head in a small, ponded marsh by Hartley Mauditt Church, but collects most of its surface-water in the plain north-east of Faringdon. The Leaven (or Lavant) Stream, an intermittent feeder of this brook, rises near Chawton, in the long, normally-dry valley of East Tisted and Basing House.

A south-western branch of the Wey gathers the rest of the Thames drainage, by way of the Oakhanger Stream and the Dead-water. The highest or ultimate source of the Oakhanger is the spring known as Well Head, at the southern end of Selborne; and the larger affluents of this stream originate to the south of Oakhanger Ponds, on the Binsted plateau, and in the Blacknest valley between the Binsted plateau and that of Alice Holt. The effluent of Woolmer Pond (now often dry), and a larger brook from the east near Lindford, form the principal local feeders of the Dead-water.

The area south and west of the main water-parting includes portions of five river-basins with independent outlets on the South Coast.

The Rother branch of the Arun, with some head-springs in a ravine south-east of Selborne, and others in the sandy ground south and west of Weaver's Down, collects the drainage of the country east of the crest-line of the Chalk upland between Noar Hill and Langrish. In its course southward from Greatham to Sheet the main stream is joined, from the west, by Batts Brook and several other small streams that head in springs at the foot of the Chalk escarpment, or originate obscurely on the clayey slopes below the Malmstone terrace ; and from the east, by short runnels from the slopes north of Rake and Sheet Commons. Below Sheet, where it turns eastward, the Rother receives a few brooks from the west and south—one of them from Stroud Common by way of Heath Pond ; but the only noteworthy northern feeder is a short bourne that joins in south of Durleighmarsh Farm. The drainage of Harting Combe escapes through a gap in the south side of that valley, and joins the Rother below Chithurst, about two miles beyond the eastern limit of the present district.

The River Meon,* in its brief course through the southern part of the district, receives only one small affluent, near Westbury House, but is appreciably swelled by springs in its channel below West Meon.

The small area about Preshaw, in the basin of the Hamble, is usually streamless, as is also the larger tract about Baybridge, Longwood House, and Longwood Warren, in the catchment of the Bow Lake branch of the River Itchen.

The springs customarily regarded as the head of the Itchen rise in Hinton Marsh or, after wet seasons, near Kilminster Church. Joined at the northern end of the Marsh by an intermittent brook from Woodcote Park, near Bramdean, their waters flow in branching channels among the cottages of Cheriton, and thence, by Tichborne House, to their conjunction with the Alre near Itchen Stoke.

The short, strongly-flowing Alre—ponded at Alresford by a considerable embankment dating from the 12th century—has its main head at or near Bishop's Sutton, and receives occasional feeders from the combes in which Bighton and Old Alresford are situated.

The longest branch of the Itchen within this area is the Candover Stream, whose head-waters oscillate between Swarraton and Preston Candover.

Below the chief confluent-point of the Itchen drainage, near Itchen Stoke, the main stream continues the westward flow of the Alre, through the picturesque marshes of Ovington and Avington, to the boundary of the district at Chilland.

East and West Stratton, and the country about Thorny Down Wood, are in the basin of the Test. The Micheldever Stream, a minor affluent of this river, rises by the side of the Winchester and Basingstoke road near West Stratton ; or, less frequently, at East Stratton, about half a mile farther up the valley.

* Pronounced 'Meen.'

Formations.—The following geological formations occur at the surface in the area under consideration, and are distinguished in the colour-printed issue of Sheet 300 :—

Recent	...	...	Alluvium.		
Pleistocene	...	...	{ River and Valley Gravel.		
			{ Plateau Gravel.		
Of Uncertain Age	...	...	Clay-with-Flints.		
Eocene	...	...	Reading Beds.		
			{ Upper Chalk.		
			{ Middle Chalk.		
Upper Cretaceous	...	...	Lower Chalk.		
			{ Upper Greensand	...	
			{ Gault	...	
			{ Folkestone Beds	...	
			{ Sandgate Beds	...	
			{ Hythe Beds	...	
Lower Cretaceous	...	...	{ Atherfield Clay	...	
			{ Weald Clay	...	
				...	Wealden.

In the absence of deep well-borings, the nature and thickness of such Mesozoic rocks as underlie the visible members of the Lower Cretaceous system are largely matters of conjecture. It is doubtful even how far the Lower Cretaceous Beds themselves extend westward of their outcrops ; though it is probable that part, at least, of the Lower Greensand Series is present beneath the Upper Cretaceous at Alresford. The more persistent Selbornian Series almost certainly is continuous throughout the western half of the district.

Structure.—The tectonic structure of this part of the country is considered in a later chapter, but a brief reference thereto may here be made in connection with the diagrammatic section which appears on the lower margin of the colour-printed edition of Sheet 300, and which shows the sequence and general attitude of the Cretaceous rocks, on an approximately east-and-west line, drawn from Harting Combe to Temple Valley.

The eastward rise of the strata, indicated in this section, is a result of the earth-movements responsible for the Wealden pericline. The Alresford area, indeed, is situated on the western flank of the Wealden dome ; and it is to the truncation of this complex earth-wave, by various detritive agencies, that the exposure of the Lower Cretaceous rocks is due.

CHAPTER II.

WEALDEN BEDS AND LOWER GREENSAND.

WEALD CLAY.

The Weald Clay appears in the bottom of Harting Combe, north of Rogate (fig. 1, p. 8), but only the highest beds there come to the surface, and these are in a much weathered condition.

The thickness of this freshwater deposit hereabouts is not known. It has been estimated at "900 or 1000 feet"* in the meridian of Leith Hill, in Surrey; but Harting Combe lies some 20 miles west of this line, and the Clay is known to vary considerably in its development.

Notes of Exposures.

Weald Clay is shown in a shallow trench on the west side of the Rake-Rogate road by the brickyard buildings marked on the map, and in small pits opened in the rising ground north and north-east of these buildings.

At the spot first mentioned it is a stiff, silty clay, coloured dull reddish-yellow, with grey mottlings.

In a pit about 200 yards north of the drying-sheds at the brickyard the descending succession is:—

	Feet.			
Soil : sandy, with scattered stones ; thin.				
Light yellow and grey, mottled sand	2
Mottled grey-brown sandy clay	about 1
passing down into				
Grey, brown-mottled, silty clay with ovoid concretions of grey and red-brown clay-ironstone ('kernel stones')	...			seen 2

Another small working, about 100 yards to the east, shows 8 feet of silty clay; mostly dull reddish-brown or yellow, and structureless; but becoming dark bluish-grey, and showing signs of lamination, near the floor of the pit. Clay-ironstone concretions occur here also.

No organic remains were observed by the writer. Mr. G. Randall, the lessee of the brickyard, stated that he had seen only one fossil shell in ten years: this, to judge from his description, not improbably was a cast of *Unio* in ironstone.

Light and dark red clays are dug in a brickyard at Cartersland (Sheet 301), a little more than two miles east of the pits just noticed.

LOWER GREENSAND.

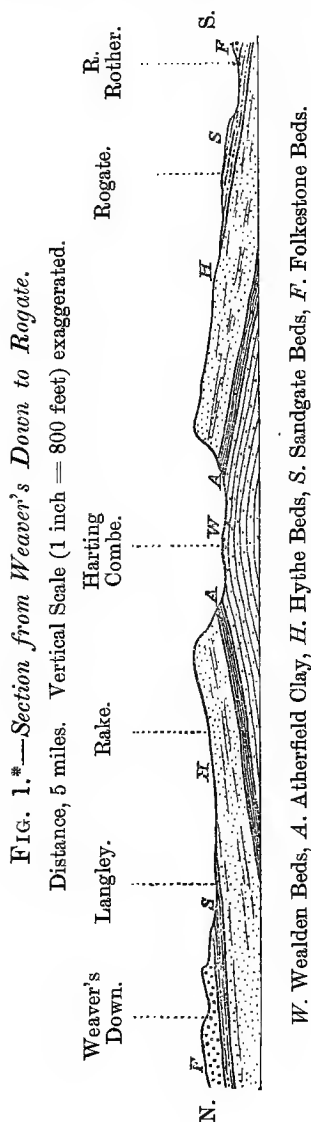
ATHERFIELD CLAY.

In this part of the Weald the Atherfield Clay is largely an arenaceous deposit, consisting of loams and sands, with little true clay. Its thickness is about 50 feet.

The only exposures worthy of notice appear to be those afforded by small pits in the timbered heath-land north and south-west of Harting Combe Brickworks. The beds shown are destitute of

* W. Topley, 'The Geology of the Weald' (*Mem. Geol. Survey*), 1876, p. 96.

fossils, and it will suffice to say that they are more or less sandy loams; brown, buff and speckled-grey in tint, and of variable texture.



* Where not stated otherwise, the illustrations in this memoir are from sketches by the author.

HYTHE BEDS.

These beds form the bulk of the rounded upland which bears the Commons of Rogate, Sheet, and Rake. They consist of evenly-stratified and current-bedded glauconitic sands and sandstones, with calcareous and cherty beds, and bands of small pebbles. Their thickness appears to be between 250 and 300 feet.

Two divisions are recognizable: a lower and thicker, in which the sands contain abundant nodules of chert with casts of sponge-spicules, and are largely cemented by this form of silica; and an upper division, in which the sands, more or less pebbly, are mixed with flakes and grains of white, calcareous matter, and in part lenticularly concreted by calcite into hard, sandy limestone or calcareous grit, known as Bargate Stone.

This upper division is impersistent, and its stratigraphical relations with other members of the Lower Greensand Series have formed the subject of some controversy. Although, in the neighbourhood of Guildford and Godalming, the Bargate Beds appear to form part of the highest or Folkestone division of the Lower Cretaceous, their analogues near Petersfield are separated therefrom by a group of strata of distinct character.

Notes of Exposures.

Where shown in a sunken lane south of Milland House, in the adjoining area of Sheet 301 and about 2 miles east of Rake, the lower cherty member of the Hythe Beds are composed of grey, "hassocky" sand; speckled with fine grains of glauconite; streaked with iron stains, and loosely bound into nodular lumps and bands by fine argillaceous sediment, which frequently shows hollow moulds of sponge-spicules. Just above the junction with the Atherfield

Beds, in a part of the lane-section now hidden by a retaining-wall, Mr. Binstead Fowler noticed some indeterminable fossils, consisting of "white phosphatic matter very similar to that at the junction of the Gault and Folkestone Beds."*

Part of the overlying sands with bands of cherty sandstone are exposed on the southern slope of Harting Combe, by the side of the Rogate road, between the contours of 400 and 500 feet. Here a pit shows about 40 feet of well-stratified brown and yellow sand and sandstone, with bands of rough chert-nodules of cindery aspect. There is an apparent south-east dip. These beds are near the middle of the Hythe series.

Sands and sandstones at a rather higher horizon, and dipping 5° south-east, are seen in a pit on the southern border of Rogate Common, north of Slade.

On the left bank of the River Rother, at the western end of Sheet Common and a little south of the Guildford road, a pit shows about 20 feet of deep orange-red and yellow, glauconitic sand; coarse-grained, obscurely bedded, and concreted in rough, cherty lumps or doggers.

A deep road-cutting south-west of Stodham House shows about 40 feet of brown, grey, and green, glauconitic sands, of rather fine texture, and containing much cherty sandstone, which occurs partly in well-defined beds (dipping gently north-eastward), partly in bands of irregular nodules, whose forms recall those of Chalk-flints.

Pale-yellow and light-brown fine-grained sandstones show in the lane-banks north-east of Pruett's Farm; and a coarser, grey, cherty sandstone is seen to the south of Popholes, at the spot where a dip of 6° south-west is marked on the map.

Brown, ferruginous, glauconitic sand with cherty concretions, near the junction with the Sandgate Beds, and resting on bright orange-coloured sand, is exposed on the banks of the high-road by the railway bridge north of Sheet Church. Brown sands and sandstone, at about the same horizon, and dipping 3° north-east, were noted by Mr. C. E. Hawkins in the railway-cutting west of Stodham House.

The calcareous sands or Bargate Beds have their chief development in a narrow belt of ground south of the Portsmouth Direct Railway, to the east of Lyss Station.

Their lower parts, well seen in stone-pits about 10 feet deep, 300 yards south-south-west of Ciddy Hall, consist of coarse, current-bedded, calcareous grit, made up of rounded grains and pebbles of quartz, of dark, siliceous, flint-like stone, and of hard ironstone; grains of glauconitic, and small granules and flakes of white, calcareous stone. The grit is partly in a loose form, partly cemented in thin lenticular and flaggy bands (Bargate Stone), which follow the south-eastward inclination of the current-bedding. Weathering converts it into dark-brown loamy sand, and the

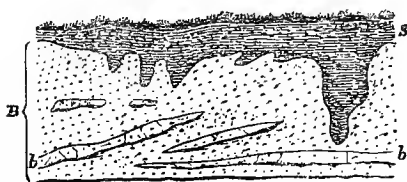
* 'The Hythe Beds of the Lower Greensand, in the Liphook and Hindhead District.' *Proc. Geol. Assoc.*, vol. xiii., 1894, p. 364.

pipied junction of this decalcified portion with the unaltered grit has a curiously jagged, step-like outline.

In the stone-bands a few ill-preserved fossils were noted: *Thetis* sp., fragments of *Ostrea* and of a large, black-shelled *Pecten*, and branching structures which are probably casts of borings.*

FIG. 2.—Section in Bargate Beds, near Lyss.

Scale, 1 inch = 16 feet.



B. Bargate Beds, b. Bargate Stone,
S. Sandy loam.

Another pit, half a mile due east of Lyss Station, shows 12 feet of beds which are probably at a rather higher horizon than those just noticed. Here a larger proportion of the calcareous grit is in a loose condition, the Bargate Stone occurring in thin impersistent bands, some horizontal, others inclined in a direction a little north of east (Fig. 2). Iron-ore is present in hard, black concretions with slag-like surfaces: sparry calcite occurs in the joint-fissures of the stone. The beds are covered and deeply piped by brown earthy sand.

In the highest part of the Bargate Beds the bands of hard stone are replaced by rough concretions, scattered through the sands. These last, in a more or less weathered condition, are exposed in lane-banks between 300 and 400 yards south-west and west of Ciddy Hall; also in the hollow lane south of Mangers, and by the road-side from one-half to one-third of a mile east-south-east of Lyss Station. Mr. W. Topley mentions the occurrence of fossiliferous nodules of Bargate Stone, "just below the Sandgate Beds," in the railway cutting "north of Rake."†

SANDGATE BEDS.

The strata mapped as Sandgate Beds are loamy sands and sandy clays; the former markedly ferruginous, of warm red-brown tint, and containing many seams and well-marked beds largely composed of polished grains and little flat-sided pebbles of hard, brown iron-ore, and pebbles of quartz. Some current-bedding is usually noticeable but on the whole the stratification is more even than in the Hythe and Folkestone Beds.

Less coherent and much less permeable than the formations above and below them, the Sandgate Beds are more quickly eroded, and their outcrop in this district is marked by belts of low, moist ground in which are situated the channels of the principal streams.

* W. H. Fitton records "*Cytherea parva*, . . . *Natica*, *Thetis minor*," from the Lower Greensand of "Lyss near Petersfield," in his 'Observations on some of the Strata between the Chalk and the Oxford Oolite, &c.,' *Trans. Geol. Soc.*, ser. 2, vol. iv., pt. 2, 1836, pp. 157-159. Some features of the Bargate Beds in this neighbourhood are noticed by B. Fowler (*op. cit.*, pp. 362, 363), and by R. I. Murchison in his 'Geological Sketch of the North-Western Extremity of Sussex, &c.,' *Trans. Geol. Soc.*, ser. 2, vol. ii., 1826, pp. 101, 107.

† 'Geology of the Weald' (*Mem. Geol. Surv.*), 1875, p. 126.

Their thickness is estimated at 60 to 70 feet. Fossils have been noted in the lower beds near Langley (north-east of Rake), but seem generally to be scarce.*

Notes of Exposures.

In the railway-cutting near Langley, Mr. F. Drew saw the following complete section of the Sandgate Beds:—

“Folkestone Beds—Buff Sand.

“Sandgate Beds”	{	Buff Sand, with drab clay in patches.
		Clay, blue, black, green, and drab, with sand.
		Dark-grained sand (8 feet).
		Light-coloured sand with ironstone (2 or 3 feet).
		Clayey sand and clay.
		Black clayey sand (5 feet).
{	Band of fossiliferous nodules, calcareous and ferruginous (1 foot).	
	Black clayey sand (6 feet).	
	Nodules (as above).	

“Hythe Beds ... Sand, with crumbly nodules of Bargate Stone (fossiliferous).

“At the east end of the cutting some of the beds are less clayey and the ferruginous nodules were not seen.”†

Evenly-bedded brown loamy sands with seams of small brown pebbles, near the base of the formation, are shown in the hollow lane south of Mangers, and a clay, which may be of Sandgate age, was noted by Mr. C. E. Hawkins in the left bank of the River Rother, north of Lyss Station.

Half a mile west-north-west of Sheet Church a sand-pit near the cross-roads gives the subjoined section in the highest beds:—

Soil : loamy thin.		Ft. In.	
Sandgate Beds	{	5. Red-brown ferruginous sand and sandstone; evenly stratified in the upper part; strongly current-bedded (towards the S.S.E.) in the lower to 4	0
		4. Dark-yellow ochreous sand, of sub-nodular structure 1	0
		passing into	
		3. Light-buff and white, evenly bedded sand with orange or reddish bands 13	0
		2. Uneven seam of small pebbles (quartz and iron-ore), in ferruginous sand to 0	6
		1. Yellow and buff sand, with rusty bands... seen	6 0

The beds dip about north-west, at 4° to 5°.

South and south-west of Sheet the Sandgate Beds form a low hill, in the eastern flank of which the two converging roads connecting Sheet and Petersfield run in deep cuttings. Here some 30 to

* W. H. Fitton (*op. cit.*, pp. 157–159) enlists the following fossils, from “Bowyer’s Common near Petersfield,” in the collection of “Mrs. Murchison”:—

“Corbula gigantea.	Lucina ?
C— striatula.	Thetis minor.
Cucullæa glabra ?	Trigonia alæformis.
Cytherea parva. (Venus, Min. Con.)	T— clavellata ?”
Gervillia aviculoides.	

These appear to be from the Sandgate Beds. In the tract of land called Bowyer’s Common, the only Lower Greensand sections known to the present writer are in the Folkestone Beds (*see below*, p. 13).

† ‘Geology of the Weald’ (*Mem. Geol. Survey*), 1875, p. 135.

40 feet of fine to coarse, red-brown, ferruginous and loamy sands are exposed; the coarser beds abounding in small brown pebbles, and cemented in places into friable iron-sandstone. Some current-bedding is exhibited, but on the whole the stratification is fairly regular, with a slight dip to the west.

On the western side of the (Tilmore) lane running north from Petersfield, at a spot where a dip of 2° south is indicated on the map, an old pit, now converted into a garden, shows about 12 feet of evenly-bedded yellow and light-brown sand. One hundred yards south of this, and at a higher level, an excavation for a drive to a new villa exposed about the same thickness of yellow and grey, well-stratified, loamy sand and sandstone; the former having the appearance of stiff clay.

In the railway cutting at Petersfield Mr. F. Drew saw, "beneath brown sand of the Folkestone Beds, 2 feet of yellow clay and 12 feet of dark coloured sandy clay with pyrites," below which (after a gap with no exposures) came "buff sand, clay, and dark-grained sand." With reference to this section Topley observes, that the "dark-grained sand . . . appears to be made up in great part of grains of ironstone," and "occurs towards the lower part of the Sandgate Beds for some miles to the east." He further notes that the clay bed here found at the top of the formation also is a persistent feature at the southern outcrop east of Petersfield.*

Mention of this clay appears in the following record of the section in a bored well made at Borough Farm Brewery, between 300 and 400 yards south of Petersfield Railway Station:—

	Feet.
"Shaft, then a tube driven [beds not described]...	20
(Folkestone Beds) { Rich loam	2
{ Mixed clay, sand, and gravel	7
{ Clean sand, then thin course of running sand ...	17
{ Clean sand, with some very green grains ...	23
(Sandgate Beds, { Blue clay	4½
37 feet) { Sand and small (fine) gravel (? broken up stone) ...	7
{ Hard blue clay	25½
	†

A section in the cutting on the Midhurst Branch Railway south of Durford and Durleighmarsh Farm is described by Topley,‡ as follows:—

"The higher [Sandgate] beds are well seen in the railway cutting north of West Heath . . . The Folkestone beds here are white and buff sand, false-bedded, with very little ironstone; but at the bottom, resting on the clay below, is a layer, from 1 to 6 inches thick, of coarse-grained iron-sandstone, sometimes changing into a concretionary ironstone. The sands have been much dug away for ballast, and this hard bed forms the floor of the excavation.

"The ironstone rests directly on dark clay with very little sand in it, not very unlike Gault; for about 10 feet down it continues the same, and then gets rather sandy until at about 15 feet it is a hardish bed of dark ferruginous sand, somewhat clayey in places. This weathers, when dry, into a yellowish iron-sandstone. At the bottom of the cutting, towards the eastern end, sands come out from under the iron-sandstone. They are buff and grey, loose and false-bedded. Springs are thrown out through this district by the clay."

North of this railway, warm brown loams and ferruginous sands, with the characteristic pebbles, are to be seen in the lanes about

* 'Geology of the Weald' (*Mem. Geol. Survey*), 1875, pp. 135, 136.

† W. Whitaker, 'Hampshire Well Sections,' *Papers and Proc., Hampshire Field Club*, vol. iv., pt. 1, 1898, pp. 37, 38.

‡ *Loc. cit.*

Slade; also in a shallow cutting on the Petersfield-Midhurst road west of Rogate; in deeper lane-cuttings to the south of that village, and in the steep right bank of the River Rother, east of Habin Farm.

No exposures were seen in the valley of the Deadwater, near Lindford.

FOLKESTONE BEDS.

The highest division of the Lower Greensand is here composed, in the main, of yellow quartz-sand, varying much in texture, and containing many seams of small pebbles which consist chiefly of quartz and dark siliceous rocks.

The sand is more or less ferruginous throughout, and especially so in the middle parts, where much of it is irregularly cemented into carstone or "clinker."

Current-bedding, with a prevailing inclination in a direction somewhat east of south, is strongly marked, except in the highest part of the formation, where the stratification assumes a more even character—the sand at the same time becoming notably micaceous, and seamed with thin layers of dull reddish-grey, laminated clay.

Ironstone casts of wood and of marine molluscs are of occasional occurrence.

The Folkestone Beds form a large proportion of the sandy country in the eastern part of the district. Broxhead Common, Woolmer Forest, and Longmoor Inclosure are situated on their outcrop, and Weaver's Down is composed of them. Their thickness near their line of outcrop on the north, between Kingsley and Greatham, probably exceeds 200 feet, but it appears to be less than this amount to the south, where the dips, though higher than in the Woolmer Forest area, seem insufficient wholly to account for the great reduction in the width of the outcrop about Lyss.

Notes of Exposures.

The lower beds are not well displayed.

Yellow and orange-coloured sands, in this part of the formation, are dug in the scarp at the eastern border of Broxhead Common.

In the northern part of the tract called Bowyer's Common, at a spot approximately 3 furlongs north-west of Stodham House, a disused pit on the east side of the high-road shows yellow, current bedded sand with bands of nodular ironstone, resting on grey sand with rusty stains. The junction is sharp, and indicates a dip of 8° north-westward, the current-bedding in the yellow sands being inclined in the opposite direction.

About 20 feet of dark-yellow sand, close above the top of the Sandgate Beds, is exhibited in the banks of Tilmore Lane, north of Petersfield. The junction with the Sandgate Beds, formerly to be seen in the adjacent railway-cutting, and in the cutting on the Midhurst Railway at West Heath, south of Duford, has been described (p. 12).

Higher beds than those above noticed are exposed in the southern part of Petersfield, and in numerous small pits and cuttings in Woolmer Forest and its inclosures.

A large pit opened in Borough Hill, at the south-western extremity of Petersfield, displays about 30 feet of coarse, yellow sands, with dark bands, and a strongly marked current-bedding, inclined to the south-south-east. Sands of the same kind are dug on the northern side of Heath Pond, and can be seen in small excavations on the heath to the west.

Similar sands are dug in pits 25 feet or more in depth on either side of the Liphook road north of Greatham Moor, and show in small gullies and other openings on the northern slope of Weaver's Down.

Yellow sands, with or without bands and ribbon-like veins of ironstone, can be seen in road-cuts and pits by the rifle-ranges south and east of Woolmer Pond, in the miniature cliff on the eastern margin of that lakelet, and in cuttings on the War Department railway in the south-east angle of the cross-roads at Wall Down.

In the north-eastern angle of this crossing sand-pits and excavations for buildings give small sections in the coarse, pebbly sand and sandstone which form the higher part of Wall Down.

At Sleaford, a pit on the north side of the road leading to Trotsford Farm shows 20 feet of orange and light-brown, coarse and pebbly sand, with a bedding at once massive and irregular. The sand is stained black in places, and contains, in addition to the usual quartz-pebbles, some angular and rounded lumps of grey and brown laminated clay.

Bright yellow sands with veins of ironstone are dug on the west side of the road between Sleaford and Malt House Farm.

A pit on Kingsley Common, and south-west of the above-named farm, presents a good section of coarse, brown sand with pebbly seams and much flaggy carstone,* the latter both in regular bands following the south-south-eastward inclination of the current-bedding, and in interlacing sheets.

The sections that remain to be noticed are in the highest part of the Folkestone Beds, and will be taken in their order from north to south.

A road-side excavation east of Lode Farm, west of Kingsley Common, shows 20 feet of light-yellow, micaceous sand with small quartz-pebbles and seams of brown laminated clay. Similar sand, with more numerous clay-seams, is dug by the ("Red Lion") inn at Oakhanger, at the turning of the lane to Hartley Wood Farm.

The junction of the micaceous sands with the Gault is well displayed at Blackmoor, but the description of the section there is deferred to the next chapter (p. 18).

A pit 400 yards south-south-west of the church at West Lyss† shows about 12 feet of the same kind of sand with clay-seams, beneath gravel and loam (*see* p. 85).

* In the Curtis Museum at Alton there are specimens of bored wood and a cast of a large dimyarian mollusc (*Cyprina*?) preserved in similar stone, labelled "Kingsley and Headley."

† Or Lyss (Liss) Upper Green, adjacent to the Petersfield-Greatham road, north-west of Lyss Station.

About one-fourth of a mile south-west of Steep Farm, north of Petersfield, road-banks and old workings show, in all, some 30 to 40 feet of sand, current-bedded in the lower part and containing seams of clay in the upper.

There are several pits in the highest beds in the northern part of Stroud Common, on either side of the road from Stroud Farm to Ridge Common. The most interesting of these lies about 200 yards west of Aldersnap Farm, and shows the junction with the Gault; the descending succession being:—

		Ft. In.
Superficial.	{ Dark loamy soil and wash, with gravelly seams and scattered phosphatic nodules in the lower part, to	4 0
	resting unevenly on	
Gault.	{ 6. Grey sandy clay... .. to	1 0
	5. Ferruginous, sandy, glauconitic clay, with phosphatic nodules (white), and some flaggy ironstone at the base	0 6
	4. Mottled grey-brown, coarse, loamy sand with scattered quartz and other pebbles (to 1 inch in diam.) and phosphatic nodules ... to	1 0
	3. Grey-brown pebbly sand, with a well-marked seam of pebbles and phosphatic nodules at the base	1 8
	2. Brown sand with fine seams of grey and pink-grey clay... .. to	0 7
Folkestone Beds.	passing into	
	1. Fine, white, micaceous sand with clay-seams (as above); current-bedded in lower part; seen	8 0

In another part of this pit* the white sand (1) was seen passing down into strongly current-bedded, coarse-grained, yellow and grey sand.

The junction with the Gault is seen again in a sand-pit one furlong west-south-west of Stroud Farm, and east of the "Seven Stars" inn. The details of this section are given below (p. 19), but it may be remarked that the top of the Folkestone Beds is here less evenly stratified than usual, and contains ferruginous concretions with fossil wood.

* This may be the pit in which W. Topley saw the section ("at the south corner of Steep Common") described on p. 142 of the Memoir on the 'Geology of the Weald.' See also below, p. 18.

CHAPTER III.

SELBORNIAN BEDS: GAULT AND UPPER GREENSAND.

The Selbornian Beds locally comprise two well-marked sedimentary groups: a lower or Gault group, consisting mainly of dark blue-grey clays and marls, but including a few thin beds of a loamy or sandy nature at the base; and a higher or Upper Greensand group, composed of grey siliceous and calcareo-siliceous rocks, termed malmstone or malm-rock.

The term "Upper Greensand" is here, on the whole, inappropriate, for the beds to which it is applied are seldom of green tint, and the proportion of mechanical sediment of an arenaceous nature in them is usually so small as to be inappreciable in ordinary hand-specimens. The malmstone, it is true, commonly acquires a sandy appearance on exposure to the weather, and is gritty to the touch, but microscopic examination shows it to be composed mainly of colloid silica, in the form of minute globules and spicules, with a varying proportion of fine clayey or marly matter.

Formerly regarded as distinct stratigraphical units, the Gault and Upper Greensand of England have been shown to be, to a large extent, merely different lithological facies of a single stage of the Cretaceous system; Upper Greensand beds in one place containing groups of organic remains which occur in Gault beds in another. Thus, the Malmstone of the eastern part of the district dealt with in this memoir represents all but the lowest portion of the Upper Gault of Folkestone, on the coast of Kent.

This relationship once clearly recognized, the need of a designation for the whole series became apparent, and Selborne was adopted as the name-place by Mr. A. J. Jukes-Browne.*

The Selbornian Beds are usually classified under the following zonal headings, here given in descending order:—

Zone of *Pecten asper* and *Cardiaster fossarius*.

- " *Schloenbachia rostrata* { Sub-zone of *Schloenb. goodballi*.
- " " *Schloenb. varicosus*.
- " *Hoplites lautus* (seldom distinguishable).
- " *Hoplites interruptus*.
- " *Douvilleiceras mammillatum* (referred by some authors to the Lower Cretaceous of British geologists).

In the Alresford district the general descending succession appears to be as follows:—

Chloritic Marl (base of the Chalk).	
Upper Greensand (80 to 200 ft.).	? Zone of <i>Pecten asper</i> { 8. Green sand?
	7. Soft, marly, micaceous, grey malmstone, with some glauconite, passing down into harder, blocky or massive grey malmstone—partly calcareous, partly purely siliceous,—alternating with thinner laminated beds of softer, silty malm, and containing regular courses and impersistent bands of grey-blue calcareous malmstone, and ill-defined masses of bluish chert.
	6. Soft, non-calcareous, silty brown-grey malm in thin beds, becoming increasingly argillaceous towards the base.
	Zone of <i>Schloenbachia rostrata</i> .

* 'Cretaceous Rocks of Britain' (*Mem. Geol. Survey*), vol. i, 1900, p. 30.

Gault (160 to 250? ft.).	Zone of <i>Schloenbachia</i> <i>rostrata</i> .	5. Grey-brown silty clay, passing into
		4. (<i>S. varicosus</i> Sub-zone) Stiff, dark grey-blue clay and marl, with selenite and phosphatic nodules.
	Zone of <i>Hoplites</i> <i>interruptus</i> .	3. Clay and marl, like that above.
		2. Stiff, dark blue-grey clay; partly calcareous, and containing phosphatic nodules, some selenite, and bands of impure limestone.
	Zone of <i>Douvilleiceras</i> <i>mammillatum</i> .	1. Dull greenish-grey and brown sandy clay, with small quartz-pebbles and phosphatic nodules, passing down into pebbly loam and sand with similar nodules.
	Sand (top of Lower Greensand).	

The sandy beds (1) at the base of the series are here referred to the *D. mammillatum* Zone chiefly on the grounds, that they closely resemble the beds which occur in a similar position at Wrecclesham near Farnham, and which have yielded *Douvilleiceras mammillatum* (Schloth.) [= *Ammonites mammillatus* Auctt.], in association with *Cleoniceras beudanti* (Brongniart).*

The Zone of *Hoplites laevis* has not been distinguished from that of *Hoplites interruptus*, nor has the existence of the Zone of *Pecten asper* been clearly established in this part of the country. A good example of *Pecten* (*Equipecten*) *asper* Lam., in a malmstone matrix (exact locality unknown), can be seen in the Curtis Museum at Alton, and the occurrence of this species, in the "Upper Greensand in the vicinity of Petersfield," is recorded by Dr. W. H. Fitton.† As, however, this form is known to range down into the Zone of *Schloenbachia rostrata*, little importance can be attached to such isolated occurrences—as Mr. Jukes-Browne, in effect, remarks.‡

Prof. C. Barrois§ and other writers have drawn attention to a bed of green sand between the Malmstone and the Chloritic Marl near Barrow Hill, to the south of Langrish and just outside the area of Sheet 300. This bed—correlated by Barrois with the "Warminster Beds (ma zone à *Pecten asper*)," though not on palaeontological grounds,—probably extends into the country dealt with in the present memoir; but no exposures of it have been observed between Langrish and Selborne; and at the latter place it is wanting.

GAULT.

(Zones of *D. mammillatum*, *H. interruptus*, and *S. rostrata*.)

The Gault sections will be noticed under the headings of the several zones, beginning with the lowest.

Zone of Douvilleiceras mammillatum.—The basal beds of the Selbornian are well exposed at Blackmoor and Stroud Common.

* See A. J. Jukes-Browne, *op. cit.*, p. 97; and H. W. Monckton and H. A. Mangles, 'Excursion to Farnham,' *Proc. Geol. Assoc.*, vol. xiii., 1893, pp. 76, 77.

There is a specimen of *D. mammillatum*, showing the peculiar lithological features of the basal beds of the Gault, in the Curtis Museum (Mechanics' Institute) at Alton. It is grouped with exhibits from the Folkestone Beds, under the general label "Kingsley and Headley."

† *Trans. Geol. Soc.*, ser. 2, vol. iv., pt. 2, 1836, p. 156.

‡ *Op cit.*, p. 105.

§ "Recherches sur le terrain crétacé supérieur de l'Angleterre, &c." *Mem. Soc. Géol. du Nord*, 1876, p. 36.

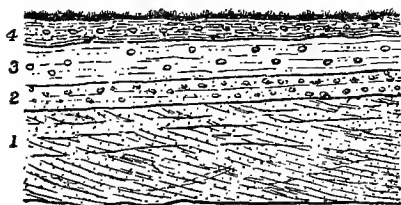
At the former place, and probably in other places where the dips are low, their sandy character has caused their outcrop to be mapped with the Folkestone Beds.

In Blackmoor village a sand-pit, situated 160 yards south-west of the cross-roads, displays the following section (fig. 3):—

		Feet.
	Soil; dark brown, sandy.	
	Wash; 4. Sand and loam with scattered flints to	2
Gault.	3. Evenly-bedded brown and yellow loamy sand, with clayey partings, many small pebbles of quartz, &c. in seams, and scattered white-coated, grey phosphatic nodules	3
	2. Evenly-bedded yellow, rusty sand with many small pebbles of quartz, &c., and small phosphatic nodules. A thin seam of grey clay at the base	1½
Folkestone Beds.	1. Yellow micaceous sands; current-bedded in detail but as a whole evenly inter-stratified with thin clay-seams, in the upper part; strongly current-bedded and containing irregular clay-seams, in the lower part seen	9

FIG. 3.—*Junction of Gault and Folkestone Beds, Blackmoor.*

Scale, 1 inch = 16 feet.



1. Folkestone Beds; 2, 3. Gault;
4. Superficial Loam.

A south-westward dip of 2° to 3° is indicated by the clearly-marked junctions of the beds.

The phosphatic nodules include sandy and pebbly material of the same character as their matrix. They are mostly of rounded, potato-like forms, and range up to about 4 inches in longest diameter. The only fossils observed were casts of bored drift-wood.

The nodules appear in the banks of the lane south-west of the pit, and at a slightly lower level.

Mr. W. Topley thus describes a section seen by him "at the south corner of Steep Common,"* more than thirty years ago:—

		Feet.
"Gault.	Green sandy clay	2
	Green sandy clay, with Phosphatic nodules	1
"Folkestone Beds.	Brown and green sand, with large pebbles, and at one place Phosphatic nodules at base	2
	White sand, with thin laminae of clay	6
	White sand	10"†

It will be noticed that the lower bed with phosphatic nodules is referred to the Folkestone Beds. In describing the similar junction-section now visible in a pit south-west of Aldersnap Farm, Stroud Common (*see above*, p. 15), the present writer has preferred to assign the corresponding bed (3) to the Gault.

* *See above*, p. 15.

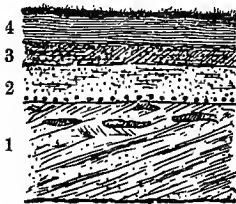
† 'Geology of the Weald,' p. 142.

Another section of the junction-beds, differing in some respects from the above, is seen in a sand-pit one furlong west-south-west of Stroud Farm, near the "Seven Stars" inn. This shows (fig. 4):—

					Ft.	Ins.
	Soil and brown stony loam	...	...	...	1	0
	4. Brown sandy clay	...	...	...	2	0
Gault.	3. Dark greenish-grey, stiff sandy clay (weathering rusty brown), with small pebbles of quartz and other material	...	...	...	1	6
	2. Grey-brown, slightly loamy sand, with an irregular seam (1 to 3 inches) of quartz-pebbles at the base	...	...	...	2	3
Folkestone Beds.	1. Yellow and white current-bedded sand, with lenticles of grey clay and concretions of iron-sandstone at the top	...	...	...	seen 7	0

FIG. 4.—*Junction of Gault and Folkestone Beds, Stroud Common.*

Scale, 1 inch = 14 feet.



1. Folkestone Beds, 2-4 Gault.

Here there are no phosphatic nodules*; and the passage from Folkestone sand to Gault clay is quicker than in the sections previously noticed.

Zone of Hoplitites interruptus.—This division includes most of the local Gault, and portions of it are exposed in all the brick-yards of the district where Selbornian clays are worked.

To commence on the south: In Mr. Gammon's brickyard, on the south side of the high road from Petersfield to Langrish at Stroud Common, and about 300 yards west of the "Seven Stars" inn, shallow pits show stiff, slightly calcareous, blue clay, containing concretions of

race, brown iron-ore, and phosphate. The few fossils seen were in an imperfect or perished condition, *Inoceramus concentricus* Park. (small) and *Hoplitites interruptus* (Brug.) alone being certainly identified. Small fragments of a costate shell, probably *Cardita tenuicosta* J. de C. Sow, are common, both in the clay and in the lower part of overlying superficial loam.

There are poor exposures in the two brickyards at Steep Marsh, west of Bowyer's Common. The large disused pits in the lower yard (a furlong south of Marsh Farm) show little save brown loam with scattered flints, but at a spot near the kilns the writer saw a small opening in dark-grey silty clay, with bored phosphatic nodules, one of which preserved the form of *Hoplitites interruptus*.

In the higher yard, south-east of Marsh Farm, a recently-worked pit showed about 6 feet of similar clay, with selenite, a few phosphatic nodules, and concretions of iron-ore. As in the lower yard, the only fossil noted was the characteristic ammonite.

At West Lyss Brickworks, north of the Hawkley road at Hurst Gate, a recent excavation shows about 15 feet of indistinctly stratified, stiff, blue-grey, calcareous clay, with few phosphatic nodules; overlain, near the southern end of the working, by a small thickness of grey-brown, silty, micaceous marl and marlstone, in which small phosphatic nodules are common. In the lower part of

* As A. J. Jukes-Browne has remarked; 'Cretaceous Rocks of Britain,' vol. 1, 1900, p. 107.

the clay exposed, well-grown examples of *Hoplites interruptus* (Brug.) and of *Inoceramus concentricus* Park. are exceedingly abundant. Other fossils noticed were *Lima* (*Mantellum*) *gaultina* Woods, *Pecten* (*Synclyclonema*) *orbicularis* J. Sow, and *P. (Neithca) quinquecostatus* J. Sowerby.

The topmost beds of the Interruptus Zone are shown in the higher (western) of two brickyards situated 3 furlongs east of Bradshott Hall, south-east of Selborne, but the description of the section there will come more appropriately under the next zonal heading, and is given below.

At Honey Lane brickyard, about a furlong north-west of Oakwood Farm, east of Selborne, a pit affords a long, shallow section of clay in the lower part of the Interruptus Zone. The clay—dug to a depth of 4 feet—is dark-grey, glossy, and very stiff; and contains small bodies and veins of sandy material, probably washed into fissures formed during seasons of drought. No fossils were observed.

Zone of Schloenbachia rostrata (lowest part).—Only two sections in the Gault beds of this zone were noticed by the writer.

One of these is in the higher of the two brickyards east of Bradshott Hall. The section seen there by Mr. William Hill in 1897, and recorded by Mr. Jukes-Browne* in 1900, was as follows:—

	Ft.	In.
"Clayey soil	3	0
[4] Bluish grey clay mottled with brown	3	0
[3] Bluish grey clay with hard stony phosphatic (?) nodules ('stone') (<i>Am. rostratus</i>)	2	6
[2] Bluish grey clay, passing rapidly down to very tough brown clay, <i>Inoc. sulcatus</i> , <i>Nucula pectinata</i> , <i>Dentalium</i> sp. ...	1	6
[1] Tough brown clay with <i>Inoc. sulcatus</i> in a marked layer ...	7-8	0"

Mr. Jukes-Browne remarks: "This section appears to be entirely in Upper Gault. The fossils here were plentiful, but all were in soft clay and difficult to preserve; there were none of the hard phosphatized casts so common in the clay pits along the base of the North Downs."†

When seen by the present writer, in 1909, the upper part of the pit-face was obscured by slips, but a little of the lowest bed [1] of the section observed by Mr. Hill was still visible; and a freshly-made trench, at a slightly lower level, showed that bed to be underlain by dark-grey clay with phosphatized casts of *Hoplites interruptus*.

The details of the section visible in 1909, including part of bed [1] of Mr. Hill's account, were:—

	Feet.
Zone of <i>Schloenbachia rostrata</i> (Subzone of <i>S. varicosus</i>).	<div> <div>c. '1' Tough grey and brown marly clay with scattered small ferruginous and phosphatic concretions ... seen</div> <div><i>Serpula</i> sp., <i>Inoceramus sulcatus</i> Park., <i>Lima</i> (<i>Mantellum</i>) <i>gaultina</i> Woods, <i>Pectunculus sublevis</i> J. de C. Sow., <i>Scaligeria</i> sp. <i>Solarium ornatum</i> J. de C. Sow. <i>Belemnites minimus</i> Lister. <i>Schloenbachia rostrata</i> (J. Sow.). <i>S. varicosus</i> (J. de C. Sow.). <i>Lamna</i> sp. (tooth).</div> </div> 3
Zone of <i>Hoplites interruptus</i> .	<div> <div>b. Section obscured for about</div> <div>a. Dark-grey, micaceous, calcareous clay, with phosphatic nodules and much selenite</div> <div><i>Cristellaria</i> sp., <i>Hamites</i> sp. <i>Hoplites interruptus</i> (Brug.).</div> </div> <div> <div>3</div> <div>2</div> </div>

* 'Cretaceous Rocks of Britain,' vol. i, p. 106.

† *Op. cit.*, p. 107.

The top of this section appears to be about 20 feet below the base of the Malmstone (Upper Greensand) Beds, fragments of which abound in the soil.

The pits in the lower (Bradshott) yard, north of the road from Blackmoor to Empshott, are in a superficial deposit (*see* p. 85).

In the fork of the roads a quarter of a mile south-west of Le Court a small drainage pit, dug in 1909, showed about 2 feet of light-brown, micaceous, silty clay or muddy malm, belonging to the passage-beds of the Gault and Upper Greensand. Concretions of red ochre, and two casts of *Schloenbachia rostrata* (J. Sow.) were found in the material thrown out of the pit.

UPPER GREENSAND (MALMSTONE).

(Zone of *Schloenbachia rostrata*, continued).

The Malmstone appears to attain its greatest thickness—about 200 feet—in the neighbourhood of Selborne. In the Wey Valley north of Binsted it is about 100 feet thick; near Petersfield,* about 80 feet.

The Malmstone seems to admit of no satisfactory division, whether on a lithological or on a palæontological basis. Purely siliceous beds, it is true, greatly preponderate in the lower parts, but they recur at short intervals up to within a few feet of the base of the Chalk; while the commoner fossils have a vertical range not less great. In describing some of the numerous exposures it will be convenient, therefore, to take them in geographical rather than stratigraphical order.

Beginning on the north:—Malmstone is exposed in the banks of all the hollow roads and lanes which radiate from the village of Binsted.

A saw-pit dug in the road-fork south of Coleson's Farm, in 1909, showed 4 feet of the lowest beds, which there consist of blocks of light-brown, micaceous, friable malm, of low specific gravity, in a matrix of soft silty clay.

Between River Hill Farm and Binsted Place a quarry on the south side of the road shows about 30 feet of beds approximately 70 to 100 feet above the top of the Gault, the section being as follows:—

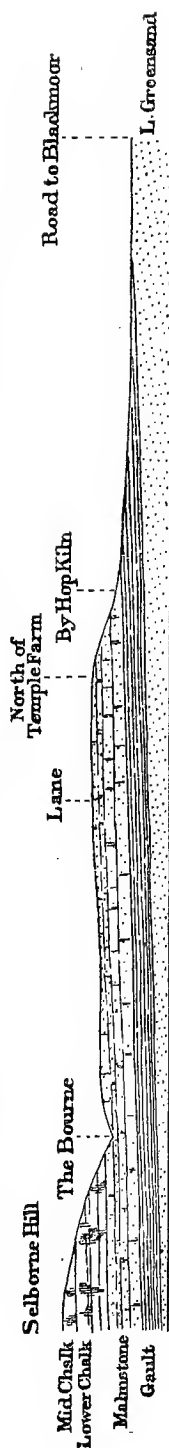
Soil.		Feet.
Upper Greensand.	4. Pale grey malmstone, in massive and in thin flaggy beds of varying hardness, about	10
	3. White, massive malmstone with hard blue lenticles	4
	2. Grey to brown, soft malm with clayey seams and small brown (phosphatic) concretions. Exfoliates spheroidally on an exposure to weather	12
	<i>Serpula</i> cf. <i>fluctuata</i> J. de C. Sow., <i>Ostrea</i> sp. (small), <i>Lima</i> (<i>Plagiostoma</i>) <i>globosa</i> J. de C. Sow.), <i>Schloenbachia rostrata</i> (J. Sow.).	
	1. Light-grey, firm malmstone, with yellow streaks: ferruginous at top seen	4
	<i>Inoceramus concentricus</i> Park.	

Spherical concretions of iron peroxide occur throughout, and all the beds are slightly calcareous.

Lower beds, of massive character, are seen in the road-cutting by River Hill Farm: higher beds are shown at the side of the same road, between Binsted

* According to C. Barrois ('Recherches sur le terrain crétacé, &c.', p. 36) and W. Topley ('Geology of the Weald,' plate iv).

FIG. 5.—Section through the Malmstone plateau near Selborne. (A. J. Jukes-Browne.)



Horizontal scale, 3 inches = 1 mile. Vertical scale, 1 inch = 1,200 feet.

(From 'Cretaceous Rocks of Britain,' vol. i., p. iii, fig. 52.)

Place and the sunken cross-roads in Binsted village. Rusty siliceous malm was noted at the turning to Wheatley.

A road-cutting west of Mill Court shows some 30 feet of massive, firm, calcareous beds, interstratified with soft laminated malm, in the upper part of the Malmstone. *Pecten* (*Syncyclonema*) *orbicularis* J. Sow. is fairly common here, and *P. (Neitheia) quinquecostatus* J. Sow. also was noted.

At Wyck, road-banks exhibit light grey and brown stone, mostly siliceous and light in the hand. Similar stone is seen south-west of the church at East Worldham.

A cutting on the road connecting East and West Worldham,* at a spot about 3 furlongs south-west of East Worldham Church, shows a band (1 to 2 feet thick) of hard, blue, slightly calcareous rock in massively-bedded, grey and rusty-brown, siliceous malmstone. Some of the higher beds of the malmstone are shown in the hollow way and water-course (named Water Lane) running from Pullen's Farm at West Worldham to the Caker Stream near Truncheant's Farm.

South-east of East Worldham a little outlier of the malmstone forms the upper part of the knoll called King John's Hill.

One-fourth of a mile north-west of Candover's Farm a recently-deepened road-cutting, in the higher part of the steep Malmstone escarpment, presents the following section of beds near the middle of the Upper Greensand:—

	Feet.
5. Grey, flaggy malm with calcite in the joints, about	15
4. Grey malmstone, in massive beds, and containing lenticular and ill-defined bodies of hard, blue, cherty stone about	25
3. Grey malmstone in massive beds, with many concretions and irregular seams of soft iron oxide, about	10
<i>Schloenbachia rostrata</i> (J. Sow.)	
2. Grey malmstone, like that above, but interbedded with thin layers of soft malm	10
Sponge-spicules abundant.	
1. Grey and brown-grey flaggy malm	5

* West Worldham is not named on the current (1905) issue of Sheet 300. The parish church is just east of Pullen's Farm.

Most of the stone here is slightly calcareous. In a road-side heap of malmstone to the east of the cutting (and perhaps taken from it) *Micrabacia coronula* (Goldf.) and numerous examples of *Exogyra conica* J. de C. Sow. were observed.

To the west of this cutting good exposures of light-grey (almost white), blocky, calcareous stone, with rough bluish bands, are shown in high road-banks south-east of Hartley Mauditt* Church.

Higher beds are shown in a sunken track and water-course about 200 yards south and south-east of Norton Farm. Here Mr. H. W. Bristow noted "a bed of hard, cherty, blue ragstone [calcareous malmstone] about a foot thick, dipping 20° south of west at an angle of 6°."†

Many sections of small depth are to be seen at and to the east of Selborne.

Rusty siliceous stone with *Pecten* (*Syncyclonema*) *orbicularis* J. Sow., near the middle of the Malmstone Beds, is exposed in the banks of the lane to Priory Farm, at points between 400 and 500 yards east-north-east of the church. Higher strata are seen in Hollow Lane (the road leading from the southern part of the village to New Barn and Oakwood Farms), and in small pits at its south-western end.

FIG. 6.—*Blue Rag in Malmstone, Hollow Lane, Selborne.*

Scale, 1 inch = 10 feet.



The banks of Hollow Lane give a good section of grey and grey-brown malmstone, of varying hardness, in well-marked beds which have an aggregate thickness of about 20 feet, and show a dip of 3° to 4° south-west. Near the middle of the section there is conspicuous ledge-making stratum (9 inches to 1 foot thick) of hard, blue to blue-grey, calcareous 'rag' (fig. 6), which contains casts of tubular borings, and which, on exposure to the weather, acquires a rough, ridgy surface, as if it were composed of thin, overlapping lenticles of varying hardness. Microscopic grains of glauconite and detrital quartz occur in this rock. The only fossils noticed

were fragments of *Ostrea* sp. and *Pecten* (*Syncyclonema*) *orbicularis*. The flaggy grey beds above this bluish rag contain small brown phosphatic nodules and ill-defined masses of chert. From the more calcareous malmstone just below it the writer obtained:—*Exogyra conica* J. de C. Sow., *Ostrea vesicularis* Lam., *Grammatodon carinatus* (J. Sow.), *Pecten* (*Syncyclonema*) *orbicularis* J. Sow., *Schloenbachia rostrata* (J. Sow.).

Between the hard blue rag seen in Hollow Lane and the base of the Chalk come about 30 feet of calcareous and siliceous beds, some of which are shown in road-banks at the south-eastern end of Selborne and, to better advantage, in Gracious Street, in the north-western part of the village.

* This name also is omitted in Sheet 300. The church is one-third of a mile east-north-east of Hartley Park Farm.

† 'Geology of Parts of Berkshire and Hampshire' (*Mem. Geol. Survey*), 1862, p. 10.

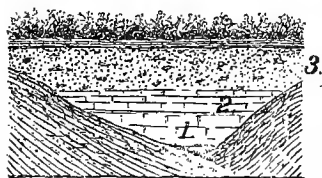
By the gate of Grange Farm (400 yards west-north-west of the church), in this street, road-banks and a small pit show a few feet of flaggy, grey malmstone, in which beds of a strongly calcareous character alternate with others wholly siliceous. The siliceous stone is, as usual, light in the hand when dry, and contains patches of bluish-grey chert; the calcareous stone is markedly micaceous; and both include small grains of glauconite. The top of this section is within 10 feet of the Chloritic Marl, whose junction with the Lower Greensand is shown in the west bank of Gracious Street, at a spot 300 yards west-south-west of the parish church.

The descending succession shown here (fig. 7) is :—

Soil : dark sandy marl		Feet.
Lower Chalk.	3. Chloritic Marl: dark grey - green, speckled, marly, glauconite-sand, with brown phosphatic nodules seen	3
	2. Dull brown-grey, soft malm, of marly aspect, in flaggy layers	2
Upper Greensand.	1. Brown-grey malmstone, becoming lighter in tint and harder downwards seen	1½

FIG. 7.—*Junction of Malmstone (Upper Greensand) and Chloritic Marl, Gracious Street, Selborne.*

Scale, 1 inch = 12 feet.



1, 2. Upper Greensand,
3. Chloritic Marl.

The malmstone and malm (1 and 2) are micaceous, strongly calcareous, and contain much glauconite in fine, sub-spherical and rod-like grains, together with a good deal of argillaceous matter. Bed (2) is traversed by borings (mostly about $\frac{1}{4}$ inch in diameter) filled with the green sandy material of the Chloritic Marl and, in other cases, with grey malm. The only fossils noted in the Upper Greensand beds here were :—Foraminifera, a few Spongiæ, *Pecten* (*Synsyclonema*) *orbicularis*, and *Plicatula* cf. *minuta* Seeley.

Dr. G. J. Hinde has observed that sponge-spicules and spicular casts abound in the Malmstone at Selborne. "Some of the casts of spicules in the more calcareous beds," he remarks, "have been refilled with crystalline calcite, whilst in sections of the more siliceous beds the spicules are seen thickly grouped together, surrounded by globular silica and also by transparent chalcedonic silica. The spicular canals are infilled by glauconite, which remains intact after the spicular walls have been dissolved."*

On the escarpment to the east of Selborne, grey siliceous malm of earthy appearance, near the base of the Upper Greensand, is shown in road-banks south-east of Temple Farm.

Harder siliceous beds, at a higher horizon, and containing *Exogyra conica* J. de C. Sow., and *Ostrea vesicularis* Lam., preserved in silica, are quarried in a road-side pit north of Burhunt Farm.

The same species, together with *Pecten* (*Synsyclonema*) *orbicularis* J. Sow., occur in massive, calcareous and cherty beds (dipping 10° west), exposed in a road-cutting on the side of a ravine west of Empshott Church.

* 'On Beds of Sponge-remains in the Lower and Upper Greensand of the South of England,' *Phil. Trans. Roy. Soc.*, pt. ii, 1885, p. 416.

Some of the highest beds are to be seen in the hollow lane running from Hawkley north-westward to Ash Farm.

For a distance of about one-fourth of a mile the north-westward inclination of the road-way nearly agrees with the dip of the strata; and for about half this distance a course of hard blue stone (8 inches to 1 foot thick) is traceable in the banks. This blue bed resembles that shown in Hollow Lane at Selborne, and appears to be on the same horizon. The grey malmstone above it shows the same alternation of siliceous and calcareo-siliceous beds as is seen in the banks of Gracious Street in that village, but the junction with the Chalk is hidden.

On the escarpment east of Hawkley, and a little to the north of the road to Greatham, a cliff caused by the landslip of 1774 (*see* below, p. 76) shows about 30 feet of grey and bluish-grey cherty malmstone in massive beds from 1 to 7 feet thick, separated by softer sandy-looking, rusty malm with concretions of red iron-ore. These beds are probably rather above the middle of the Upper Greensand. The fossils noted were:—*Exogyra conica* J. de C. Sow., *Ostrea sp.*, *Pecten (Syncyclonema) orbicularis* J. Sow., *Plicatula gurgitis* Pict. and Roux, *Schloenbachia rostrata* (J. Sow.).

Another section, also on the escarpment, and near the same horizon as the last, is shown in a pit by the east side of the road from Hawkley to Lyss, at a point a little north-west of the V-shaped bend in that road. The excavation is about 10 feet deep, and exhibits grey and pale-brown, micaceous and slightly calcareous stone in four boldly-jointed beds, each about two feet thick, with softer, rusty, laminated malm in thin layers between. The bedding dips 10° north-westward. Casts of *Schloenbachia rostrata* are plentiful; the other fossils seen were of the same species as those noted in the last section, with the addition of *Grammatodon carinatus* (J. Sow.), *Ostrea vesicularis* Lam., *Pecten (Neithea) quadricostatus* J. Sow., and *P. (N.) quinquecostatus* J. Sowerby.

There are many exposures of the highest beds in the lane which follows the foot of the Chalk escarpment from Hawkley Church, by Higher Oakshott Farm, to Wheatham Hill, but few of these call for notice. A rough-faced bluish bed, like that seen in Hollow Lane at Selborne and near the same horizon, was noticed to the east of Middle Oakshott Farm, east of Warren Corner. At Higher Oakshott Farm a temporary excavation showed a few feet of greenish-grey siliceous malm containing fine grains of glauconite.

The speckled, grey, calcareous malmstone exposed in a road-bank on the south-eastern side of Wheatham Farm, and in a small quarry one-fourth of a mile south of that place, is noteworthy as containing a considerable proportion of fine quartz-sand, as well as fine-grained glauconite. This rock is the nearest approach to sandstone that the writer noticed in the Upper Greensand of the district under consideration. It lies in the upper part of the Malmstone Beds, but below the horizon of the thin green-sand bed of Barrow Hill, mentioned in the introductory portion of this chapter.

There are good exposures of the middle and lower beds in the road-cutting on the escarpment north of Marsh Farm; and others of less size can be seen in the lanes about Ashford House, but nothing of especial interest was observed in them.

Of the Upper Greensand ("*zone à Am. inflatus*") near Petersfield, Prof. C. Barrois writes: "it is a grey stone (*grès*), sandy, light, and micaceous, containing parts that are bluish and siliceous; the village of Langrish which stands on this rock might well be a village in Argonne, with its many woods and steep ravines on all sides,

"The Upper Greensand dips gently towards the west; at Langrish its inclination does not exceed 3° : its thickness is 25 metres [80 feet]. I collected there a large number of *Ammonites inflatus* [= *Schloenbachia rostrata*] and *Pecten laminosus* [= *P. (Syncyclonema) orbicularis*]."*

The Malmstone of Langrish, however, cannot, with propriety, be described as "sandy (*sableux*)."[†] In the small exposures of its upper beds to be seen in road-banks south of the village it presents much the same features as in the sections about Hawkey and Selborne.

Dr. W. H. Fitton[‡] recorded about 20 species of fossils from the "Upper Greensand in the vicinity of Petersfield," in 1836.

* 'Recherches sur le terrain crétacé, &c.,' 1876, p. 37.

† Barrois (*op. cit.*, p. 37) terms the Upper Greensand of this part of the country "Gaize de Langrish," but it differs materially from his "Gaize de Devizes" (p. 62).

‡ 'Observations on some of the Strata between the Chalk and the Oxford Oolite, in the South-east of England,' *Trans. Geol. Soc.*, ser. 2, vol. iv., pt. 2, pp. 156, 157.

CHAPTER IV.

CHALK.

If the superficial deposits be disregarded, the Chalk can be said to occur at the surface over roughly three-fourths of the country represented on the Alresford Sheet of the Geological Map.

Its maximum thickness hereabouts is unknown, but it is not likely to be much less than 950 feet. This, though approximately twice the thickness accounted for at the boldest part of the escarpment north-west of Petersfield, is a fair estimate of the distance of the top of the Selbornian Beds from the surface of the ground at some points on the ridge immediately to the north of the River Meon.

The three divisions or stages shown on the map can, as a rule, be readily distinguished in the field by their lithological characters the chief of which (in this district) are :—

Upper Chalk.—Typically a pure white chalk ; for the most part soft and homogeneous, but becoming hard and nodular, and assuming a greyish or yellowish tinge, towards the base.

Flints occur plentifully almost throughout, but are more abundant and larger in the lower, than in the upper half.

Middle Chalk.—A white to greyish-white chalk ; mainly soft to firm and homogeneous, but containing hard, nodular beds in the lower part, and, to a less extent, in the upper part. Nodular Melbourn Rock at the base.

Flints are small and scarce ; and seem to be confined to the highest and lowest beds.

Lower Chalk.—Grey, blue-grey and grey-brown, firm, marly limestone and soft marl ; becoming somewhat sandy and glauconitic near the base, which is marked by dark-green Chloritic Marl.

Flints absent, or very rare.

Of the minor, zonal and sub-zonal divisions, which are distinguished by certain fossils or small groups of fossils, the following have been recognized locally :—

	Zones.	Sub-Zones.
Upper Chalk.	Actinocamax quadratus.	{ Marsupites ' Band.'
	Marsupites testudinarius	
	Micraaster coranguinum.	{ Uintacrinus ' Band.'
	Micraaster cortestudinarius.	
Middle Chalk.	Holaster planus	{ Heteroceras reussianum.
	Terebratulina lata.	
	Rhynchonella cuvieri.	
Lower Chalk.	Holaster subglobosus	{ Actinocamax plenus
	Schloenbachia varians.	

The zone of *Actinocamax quadratus* appears to be not fully developed.

In preparing the following account of the local Chalk, the writer has made use of notes which have already appeared in Mr. Jukes-Browne's Memoir on the Upper Cretaceous Rocks and in other works, but the bulk of the information conveyed is published now for the first time.

The writer is indebted to Dr. A. W. Rowe for lists of the fossils collected by him during the spring of 1908, and to Mr. C. Griffith, of Winchester College, for information concerning some of the sections in the Upper Chalk.

LOWER CHALK.

This division outcrops in a strip of country, from a few hundreds of yards to 2 miles wide, extending from the purlieu of Holybourne, southward, to Langrish; and in a few small areas, in the Meon Valley, at the southern border of the district. On the broader parts of its baset surface, about Faringdon and Alton, the ground, on the whole, is but gently inclined and is mostly under cultivation: on the narrower parts, as at Selborne, Empshott, and to the north-east of Langrish, steep slopes are the rule, and much of the ground is wooded.

The Lower Chalk, which includes or comprises the beds called 'Chalk Marl' and 'Grey Chalk,' appears to be about 180 to 200 feet thick at Selborne and at Stoner Hill. Its lower division, or Zone of *Schloenbachia varians*, consists of indistinctly-stratified, bluish to brownish grey marl or marlstone, of homogeneous appearance and exhibiting conchoidal fracture when newly quarried, but developing a laminate, shaly structure after a brief exposure to the weather. Hard calcareous nodules, and smaller, brown phosphatic concretions are not uncommon; and bands of gritty marlstone, notably harder than the rest, occur in the upper, and, less frequently, in the lower parts of the zone. The distinctive basement-bed, termed Chloritic Marl, is a dark olive-green, brown-streaked, marly glauconite-sand, $1\frac{1}{2}$ to 5 feet thick, and containing more or less thickly disseminated brown phosphatic concretions, of nodular and tabular form.

The Chalk of the *Holaster subglobosus* Zone is, on the whole, firmer and less marly than that of the zone below. It occurs in massive, irregularly-jointed beds, varying in colour from pale grey (nearly white when dry) to light yellowish-grey; the yellow tinge being largely due to little rusty streaks and spots, which, in greater or less degree, characterize nearly all the beds in this sub-division of the Chalk. Roughly spherical and cylindrical nodules, and small vermiform concretions of marcasite (passing into red iron oxide) also are conspicuous features.

About 10 feet below the top of this zone the chalk becomes notably marly and of darker tint, and eventually passes (with some alternation of lighter and darker beds) into grey or greenish-grey, laminated marl, about a foot thick, on which rests the Melbourn Rock. These argillaceous beds* constitute the Belemnite Marls, or Sub-zone of *Actinocamax plenus*. The junction with the hard Melbourn Rock is sharply defined and slightly undulate.

The thickness of the *H. subglobosus* Zone is estimated to be about 80 feet, and that of the *S. varians* Zone about 100 to 110 feet.

The principal sections will be noticed in their order from north to south.

Zone of Schloenbachia varians.

Prof. Barrois mentions† a section at Neatham, north-east of Alton, which showed bluish-grey marl, with numerous little brachiopods (" *Rhynchonella Mantellana*, Sow." and " *Terebratulina*

* The characteristic belemnoid, *Actinocamax plenus* (de Blainv.), seems not to occur below the highest, laminated bed in the present district, though it does so near Winchester.

† 'Recherches sur le terrain crétacé supérieur de l'Angleterre, &c.', 1876, p. 44.

striata, Wahl”), close above the Chloritic Marl. The whereabouts of this exposure is doubtful. A little grey silty marl with grains of glauconite, at about the horizon indicated, is shown in the lane north-east of Neatham, at a spot about one furlong south-east of Cuckoo’s Corner.

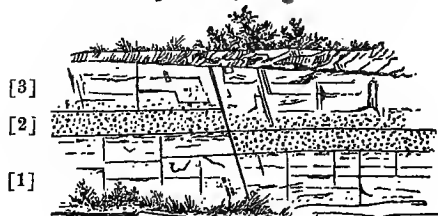
A good section of the Chloritic Marl was formerly to be seen in a shallow quarry in Stirvill’s Copse, midway between Neatham and Wyck and three-quarters of a mile north-north-east of Clay’s Farm.

Mr. F. Drew states,* that the Marl is there “affected by a small fault which has caused a downthrow of the beds in a northerly direction of about three feet in amount. The thickness of the Chloritic Marl being also there about three feet, the effect of this disturbance has been to bring the upper part of the Chloritic Marl on the north side of the fault to a level with the bottom of the same bed on the other side” (fig. 8).

In 1896, Mr. William Hill found the quarry overgrown with trees and shrubs, but, by clearing the south-eastern corner, he was able to make out the following succession :—

		Ft.	In.
“Chalk Marl.	{ [3] Hardish white marly chalk, passing rapidly down to a very glauconitic marl	0	4
	<i>Schloenbachia coupei</i> .		
“Chloritic Marl.	{ [2] Firm, very glauconitic marl, with many brown phosphates and large calcareo-siliceous lumps, brownish-grey interiorly, but with a paler rind, as large as a double fist	1	6
	<i>Avicula gryphæoides</i> [<i>Aucellina</i> Auctt.] and a large <i>Nautilus</i> .		
“Upper Greensand.	{ [1] Grey-brown silty or sandy marl into which the glauconite material above is piped ...	1	6
		7	0”†

FIG. 8.—Section of Chloritic Marl, near Wyck. (after F. Drew.)



[1] Upper Greensand, [2] Chloritic Marl, [3] Chalk.

Another exposure of the Chloritic Marl, also rather obscured by trees and undergrowth, occurs in Water Lane, a quarter of a mile north-east of Truncheant’s Farm. Among the Chloritic-Marl fossils, from this locality, exhibited in the Curtis Museum at Alton, is an example of *Hoplites falcatus* (Mant.).

Grey laminated marl, with *Rhynchonella mantelliana* (J. de C. Sow.) and large *Cristellaria rotulata* Lam., near the base of the Lower Chalk, appears in a road-bank half a mile north-north-east of Truncheant’s Farm.

* ‘Geology of the Weald’ (*Mem. Geol. Survey*), 1875, p. 156.

† In ‘The Cretaceous Rocks of Britain’ (*Mem. Geol. Survey*), vol. ii., 1903, p. 59. Messrs. J. M. Paine and J. T. Way (‘On the Phosphoric Strata of the Chalk Formation,’ *Journ. Roy. Agric. Soc.* vol. ix., 1848, p. 75) state that the Chloritic Marl of this section, exclusive of the fossils, “contains a percentage of—

Carbonate of lime	...	...	...	...	25.72
Phosphate of lime	...	...	...	...	14.92
Potash	...	...	...	...	2.69
Soda	...	...	...	...	.50”

In a field-pit half a mile south of Barleywood Farm, and about a mile east-north-east of Faringdon, Mr. W. Hill observed the following section (about 1896):—

		Ft.	In.
"Soil ...	... ..	1	0
	Chalk rubble	4	0
"Chalk Marl.	{ Whitish-grey (very dry) marly chalk, with hard masses arranged in layers:— <i>Schloen[bachia] varians</i> , <i>Rynch[onella] grasiana</i> , <i>Ter[ebratula] semiglobosa</i> ; passing down to the next ...	2	6
"Chloritic Marl.	{ Firm micaceous glauconitic sandy marl with brown phosphates and large calcareo-phosphatic lumps:— <i>Schloen[bachia] varians</i> , <i>Avicula gryphæoides</i> [<i>Aucellina</i>], <i>Plicatula gurgitis</i> , and a large <i>Nautilus</i>	3	6
"Upper Greensand.	{ Soft grey silty and sandy marl into which the glauconitic material is piped	1	0
		12	0"*

The pit is now somewhat degraded, and no longer shows the base of the Chloritic Marl, but it affords the best section of that bed at present existing in the district. The writer noted brown lignite and *Teredo* cf. *amphisbæna* (Goldf.) in the Chloritic Marl, and a branching object, like the so-called '*Spongia paradoxica*,' in the whitish-grey bed above. This bed is glauconitic.

At Selborne, portions of the Varians Zone are shown in road-banks, and in three pits to the west of the main road through the village.

The exposure of the junction of the Chloritic Marl with the Upper Greensand in Gracious Street is described above (p. 24). The top of the Marl is poorly shown under a hedge at the northern end of this street, and in a ditch at the eastern side of the road to Empshott, nearly one furlong south-east of the turning to East Tisted. From the exposures in Gracious Street the writer obtained—*Kingena lima* (Defr.), *Aucellina gryphæoides* (J. de C. Sow.), *Pecten* (*Syncyclonema*) *orbicularis* J. Sow., *Plicatula* sp. In the Curtis Museum (Alton) there are specimens of *Pleurotomaria perspectiva* (Mant.), *Schloenbachia varians* (J. Sow.), *Lamna appendiculata* Agass. (tooth), and other fossils, from the same locality.

Higher beds of the zone, consisting chiefly of grey and blue-grey marl and marlstone, are worked in a quarry (about 35 feet deep) by the Newton Valence road, 5 furlongs west-north-west of Selborne Church. Near the top of the pit, and out of reach, is a thin bed of hard, gritty, brown stone, having an irregular fracture, and containing a few green-coated, ferruginous nodules and grains of pale-green glauconite. From the subjacent marl the writer got:—*Fronicularia* sp. (large), *Porosphæra patelliformis* Hinde, *Onchotrochus* sp., *Serpula plexus*? J. de C. Sow., *Kingena lima* (Defr.), *Rhynchonella mantelliana* (J. de C. Sow.), *R. martini* Mant., *Terebratulina striata* Dav., *Inoceramus crippsi* Mant., *Lima* (*Plagiostoma*) *globosa* (J. de C. Sow.), *Ostrea lateralis*? Nilss., *O. vesicularis* Lam., *Pecten* (*Æquiptecten*) *arlseiensis* Woods, *Plicatula*

inflata J. de C. Sow., *Nautilus deslongchampsianus* d'Orb., *Schloenbachia varians*, *Pollicipes glaber* Roemer. The collection of Selborne 'Chalk Marl' fossils (from "near Fisher's Buildings") in the Curtis Museum may have come from this quarry. It includes *Turrilites costatus* Lam., *T. tuberculatus* Bosc., *Mantelliceras mantelli* (Sharpe), *Calycoceras naviculare* (Mant.).

Flaggy marl, probably rather lower in the zone than that just noticed, is exposed in a small pit at the lower edge of Selborne Hanger, one-fourth of a mile south-west of the church. Examples of *Plicatula inflata* J. de C. Sow. and *Schloenbachia varians* are common here.*

In the south bank of the road leading from Selborne to East Tisted, at a point a little to the east of the cottages 5 furlongs due south of Selborne Church, a pit shows about 8 feet of grey fissile marl, in the upper part of the Varians Zone. The writer's list from this section includes the zonal name-fossil, *Pollicipes glaber*, and almost all the other forms seen by him in the Newton Valence-road quarry described above, with the addition of *Serpula ampullacea* J. de C. Sow., *Nautilus elegans* ? J. Sow., *Enoplochyttia sussexiensis* ? Mantell.

Higher beds show in the road-banks south-west of the pit (near the top of the rise called Gally Hill), and in these, fragmentary examples of *Calycoceras naviculare* (Mant.), *Mantelliceras mantelli* (Sharpe), and *Metacanthoplites rotomagensis* (Brong.) were noted; the first-named in a firm yellowish chalk (on the 500 feet contour), near the upper limit of the Varians Zone.

A grey marl near the middle of this zone, poorly exposed in a road-side pit 100 yards north of Ash Farm, south-west of Empshott Green, yielded:—*Plocoscyphia mæandrina* Goldf., *Serpula ampullacea* J. de C. Sow., *S. pleurus* J. de C. Sow., *Rhynchonella mantelliana* (J. de C. Sow.), *R. martini* Mant., *Inoceramus crippsi* Mant., *Pecten (Neitheia) quinquecostatus* J. Sow., *Lima (Plagiostoma) globosa* J. de C. Sow., *Plicatula inflata* J. de C. Sow., *Schloenbachia varians* (J. Sow.).

Fossiliferous beds, from 10 to 20 feet above the Chloritic Marl, are shown in lane-banks 200 yards south of Ash Farm. They are mostly fissile grey marls, but in the lowest and southernmost part of the exposure there are one or more thin, discontinuous bands of hard, blue-grey and buff, nodular stone, crowded with casts of *Schloenbachia varians* (J. Sow.), in association with *Schloenbachia coupei* Brongniart. Besides these, and several of the common fossils noted in the previous section, the following were found:—*Cidaris dissimilis* Forbes (radioles), *Cardita* sp., *Grammatodon*

* Gilbert White ('Natural History of Selborne,' *Pennant Letter*, 3) remarks the occurrence of "large *nautili*" in a pit (now degraded) at the "north-west end of the Hanger"; and of "*cornua ammonis*" in one of the pathways through that wood, as well as in places south and south-east of Selborne. He figures (under the name of "*Mytilus, Crista Galli*") an example of *Alectryonia frons* (Park.), "that was ploughed up in the chalky fields near the side of the Down," and that probably came from the Varians Zone. There is a specimen from the "Chalk Marl" of Lynch Hill (east of Ansty Mill, near Alton) in the Curtis Museum.

carinatus (J. Sow.), *Pecten* (*Chlamys*) *cretosus* Deufr., *Ostrea lateralis* Nilss., *Baculites baculoides* Mantell.

Continuing southward, the next section seen is that in a conspicuous quarry, some 70 or 80 feet deep, on the southern termination of the lofty spur (Farrow Hill) of the Chalk upland west of Hawkley. Excepting a small cliff, 15 to 20 feet high, at the top, and a few ledges in the upper and middle parts, the face of the working is enveloped in loose talus. The upper beds, forming the cliff, consist of yellowish-grey to white chalk with rusty streaks, and is boldly and irregularly jointed, except at the base, where, for a thickness of $1\frac{1}{2}$ feet, the jointing is close and sub-rectangular. No fossils were seen in the small accessible portions of this chalk, which probably belongs to the *Holaster subglobosus* Zone. The underlying beds, showing in the ledges, are of grey and grey-brown flaggy marl, with occasional seams of sparry calcite, and courses of harder, sub-nodular, grey-brown marlstone. In these the writer saw no remains of *Schloenbachia varians*, but it is nevertheless probable that they mostly pertain to the upper part of the Varians Zone: they yielded—*Cidaris dissimilis* Forbes, *Dimyodon nilssoni* (v. Hag.), *Rhynchonella mantelliana* (J. de C. Sow.), *R. martini* Mant., *Terebratula semiglobosa* J. Sow., *Terebratulina striata* Day., *Cardita* sp., *Inoceramus cripsii* Mant., *I. tenuis* Mant., *Ostrea vesicularis* Lam., *Lima* (*Plagiostoma*) *globosa* J. de C. Sow., *Plicatula inflata* J. de C. Sow., *Trochus* sp., *Baculites baculoides* Mant., *Metacanthoplites rotomagensis* (Brongn.); the last-named, in fragmentary casts, being observed only in the upper part of these marly beds. The specimens of *Calycocercus naviculare* (Mant.), *Mantelliceras mantelli* Sharpe, and *Schloenbachia varians* (J. Sow.), labelled "Hawkley," in the Curtis Museum, Alton, may be from this quarry.

A poor exposure of the upper part of the Chloritic Marl was noted in a road-bank, by the entrance to the garden of a new house, three furlongs north-west of Wheatham Farm.

A good section of the upper half of the Varians Zone is displayed in a quarry on the eastern angle of Wheatham Hill. The descending succession is thus described by the Mr. Jukes-Browne* :—

	Ft.	Ins.
" Soil	2	0
Greyish (wet) rather marly chalk	13	0
Greyish rather marly chalk, mottled with large patches of bluish-grey	8	0
Hard grey sandy chalk, <i>Terebratula biplicata</i>	2	0
Softer chalk, mottled with large patches of bluish-grey	6	0
Hard grey chalk [<i>Metacanthoplites</i>] <i>rotomagensis</i>	1	0
Bluish-grey marly chalk, passing down to greyer chalk	4	0
Grey firm chalk, slightly mottled with bluish-grey	4	0
Massive firm marly chalk mottled with large patches of bluish-grey	15	0
	55	0"

* 'Cretaceous Rocks of Britain,' vol. ii, 1903, p. 59.

The beds dip north-west, at about 10° . The bluish tint of the chalk here is especially noticeable in wet weather, when the aspect of the more shaly beds strongly recalls that of the Lias marls. The fossils noted by the present writer comprised most of the forms recorded from the sections described above, but mention may be made of the following:—*Lima (Plagiostoma) globosa* (J. de C. Sow.), abundant, *Panopæa mandibula* (J. Sow.), *Pleurotomaria* sp., *Scalardia fasciata* Eth., *Baculites baculoides* Mant., *Metacanthoplites rotomagensis* (Brongn.), *Lamna appendiculata* Agassiz.

M. rotomagensis was abundant in blocks of rather hard, rusty, gritty chalk, fallen from the upper part of the quarry.

The Chloritic Marl, and some of the grey marls above it, appear in road-banks between one-fourth and one-third of a mile south to south-south-west of Ashford House.

At Langrish, Prof. Barrois* saw bluish marl with "*Rhynchonella Mantellana*, Sow.," and "*Ammonites varians*, Sow.," in the foundations of a house near the church.

Zone of *Holaster subglobosus*.

The laminated grey marl and marly chalk of the *Actinocamax plenus* Beds, at the top of this zone, are poorly exposed at an altitude of about 400 feet O.D., in a road-cutting 3 furlongs north-west of Holybourne Church.

A good section of the upper half of the zone and its junction with the zone above is presented in the quarry at Wilsham Lime Kilns†, 400 yards south-east of the railway station at Alton.

The descending succession here is (fig. 9):—

		Feet.
Zone of <i>Rhynchonella</i> <i>cuvieri</i> .	5. White flaggy chalk, firm to hard	3
	4. Melbourn Rock: hard, white, nodular chalk, with small, bored nodules of hard brown chalk scattered through it and forming a well-marked layer at the base	about 7
Zone of <i>Holaster</i> <i>subglobosus</i> .	Act. <i>plenus</i> Marls. { 3. Dark-grey laminated marl containing rounded pieces of a grey chalk like that just below	1 to 2
	{ 2. Grey marly chalk, closely jointed passing into	about 6
	1. Greyish massive chalk, with spherical and sub-cylindrical concretions of radiate marcasite	seen, about 40

The upper beds show a south-east dip, decreasing south-eastward from about 10° to about 3° .

* 'Recherches sur le terrain crétacé, &c.,' 1876, p. 36.

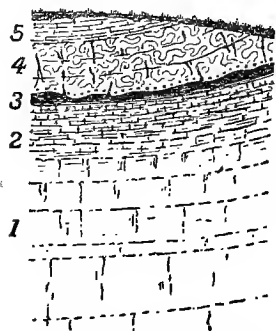
Barrois, who does not recognize a Zone of *Schloenbachia varians* in this work, speaks of the bluish beds near the church as the "upper part (*partie supérieure*)" of the "Zone of *Holaster subglobosus*"; but it is evident that "lower part" is meant.

† This appears to be the quarry briefly noticed in 'Cretaceous Rocks of Britain,' 1903, p. 61, third par.

In the lowest bed (1) the writer noted,—Casts of borings up to half-an-inch in diameter, *Terebella lewesiensis* Davies, *Serpula ampullacea* J. de C. Sow., *Terebratulula semiglobosa* J. Sow., *Dimyodon nilssoni* (v. Hag.), *Cardita*?, *Inoceramus crippii*, Mant., *I. tenuis* Mant., *Ostrea vesicularis* Lam., *O. hippopodium* Nilss., *Pinna tegulata*? Eth., *Plicatula inflata* J. de C. Sowerby.

FIG. 9.—*Junction of Lower and Middle Chalks, Wilsham.*

Scale, 1 inch = 20 feet.



- 1-3. Lower Chalk
(2, 3, *Act. plenus* Marls);
4-5. Middle Chalk
(4, Melbourn Rock.)

In bed (2), which was not well exposed in 1909, the only fossil seen was *Ostrea vesicularis*, but the laminated marl (3) yielded a few imperfect guards of *Actinocamax plenus* (de Blainv.), together with *Ostrea vesicularis*, *O. hippopodium*, *Dimyodon nilsoni*, *Teredo amphibia* (Goldf.).

From the Melbourn Rock (4), *Rhynchonella cuvieri* d'Orb., *Ostrea vesicularis*, *Inoceramus brongniarti* J. de C. Sow., and *I. mytiloides* Mant., were obtained.

It is probable that many of the Lower Chalk fossils labelled "Wilsham," in the Curtis Museum, were collected in this quarry. They include several well-preserved guards of *Act. plenus*.

Mr. Jukes-Browne states that, "in a small disused road-side quarry about one-third of a mile S.S.E. of Alton Station, and again in a quarry half-a-mile N.N.E. of Farringdon [Faringdon], a grey gritty chalk somewhat like Totternhoe Stone was exposed, in which *Pecten orbicularis*, *Kingena lima*, and *Rhynchonella grasiana* were common, but there were no *Ammonites*."*

A small quarry, now used as a miniature rifle-range, 400 yards west of Faringdon Church, shows 20 feet of light-grey chalk, in which thin beds of a soft and marly character alternate with others more firm and blocky. This quarry is just below the line of the Middle-Chalk boundary as mapped, but the beds exposed have a different aspect from those in the upper part of the Subglobosus Zone at Wilsham Lime Kilns. The only fossils observed were *Cardita* sp., fragmentary *Inocerami* (*I. crippii*? Mant., *I. lamarchi* Park.), and *Ostrea vesicularis* Lamarck.

Rather more than 3 furlongs south-east of Faringdon a little greyish-white chalk is shown at the top of a degraded field-pit; and indications of the Plenus Marls were noticed in a road-bank half-a-mile south-east of the church at Newton Valence.

There are small exposures of poorly-fossiliferous beds, in the middle and lower parts of the Subglobosus Zone, south-east of King's Farm near Noar Hill, and in the roadway east and south-east of the fine old farmhouse of Goleigh.

* 'Cretaceous Rocks of Britain' (*Mem. Geol. Survey*), 1903, p. 61. The first of these sections is now obscured.

The junction with the *Rhynchonella cuvieri* Zone is shown in a lane-bank 300 yards north-east of Baker's Farm, west of Hawkey. Here the succession is :—

			Feet.	
Zone of <i>Rhynch. cuvieri</i> .	}	5. Melbourn Rock: hard white, nodular chalk	seen 5	
Zone of <i>Holaster subglobosus</i> .	{	{ Act. plenus Marls.	4. Dull greenish-grey to buff, laminated marl	1
			3. Pale yellowish-grey, firm, blocky chalk, with ferruginous stains	2
			2. Grey marly chalk, obscurely laminated where weathered	1
			1. Yellowish and greyish white, firm chalk	seen 1

No fossils were seen.

The same group of beds appears in another road-bank, situated about 150 yards to the south-west of the church at Prior's Dean,* but here the bedding is disturbed by hill-side creep or other movement, which at some points has pinched out the laminated marl (=4 of the last section), and in others has incorporated it with broken fragments of the underlying yellowish-grey chalk. In this last, *Ostrea vesicularis* Lam. was noted, and some small, white, calcareous concretions with tapered, horn-like prominences.†

As remarked above (p. 32), it is probable that the highest part of the chalk seen in the degraded quarry in Farrow Hill, west of Hawkey Church, belongs to the Subglobosus Zone. Mr. Jukes-Browne, indeed, notices‡ this quarry under the Subglobosus zonal heading alone; and he states that it shows some gritty chalk, in which Mr. Hill found the same fossils as in the similar chalk observed to the south-south-east of Alton Station (see above, p. 34), "with the addition of *Pecten elongatus*, *Terebratulina striata*, . . . *Trochus buvignieri*, . . . [and] impressions of an Ammonite."§ This gritty bed, which, according to Mr. Jukes-Browne, "appears to be about 60 to 65 feet below the Melbourn Rock," the present writer was unable to identify.

A yellowish massive chalk, with few small, greenish concretions, and yielding *Serpula ampullacea* J. de C. Sow., *Pecten* (*Neithea*) *quinquecostatus* J. Sow., *Nautilus* sp., and fragments of an ammonite (? *Metacanthoplites cenomanensis* (d'Arch.)), is shown in a disused road-side pit on the eastern slope of Stoner Hill, at a point about a quarter of a mile south-west of Ashford House.

Mr. Jukes-Browne mentions that "the outcrop of the [*Act. plenus*] marl was observed, in 1897, in a bye-road crossing Ridge Hanger to Stoner Hill, two miles north-west of Petersfield, just above the contour line of 600 feet."||

At Bordean Lime Works, 300 yards north-west of the church at Langrish and on the northern side of the high-road to Lower Bordean, a large quarry displays 60 or 70 feet of massive, yellowish and greyish-white chalk, with many stout concretions of radiate

* The name of this secluded settlement does not appear upon the map. The church is that marked to the south-west of Manor Farm, 1½ miles west of Hawkey.

† Similar concretions, from the neighbourhood of Alton, are in the Curtis Museum.

‡ *Op. cit.*, p. 61.

§ *Loc. cit.*

|| *Op. cit.*, p. 62.

marcasite. The beds appear to dip somewhat north of west, at about 10°. This quarry is in constant use, but the workmen say that they find few fossils; and the writer noted only,—Impressions of *Algæ*, *Holaster trecensis* Leym. (in the upper part of the quarry), *Pecten* (*Æquipecten*) *beaveri* J. Sow. and part of an ammonite—? *Mantelliceras mantelli* (J. Sow.). A few fish-remains, collected by the quarry-men, included teeth of *Lamna appendiculata* Agas., and *Ptychodus polygyrus* Agassiz.

There are old workings on the south side of the high road by Bordean Lime Works: it may have been in one of these that Prof. Barrois found the "*Turrilites costatus*, Lk; *Ammonites Rotomagensis*, Defr.; *Baculites baculoides*, d'Orb., [and] *Inoceramus striatus*, Mant.,"* which he records from this neighbourhood, and which are suggestive of the upper part of the Varian's Zone.†

In the Meon Valley no exposures of Lower Chalk were seen within the area of Sheet 300.

* 'Recherches sur le terrain crétacé, &c.,' p. 36.

† See Jukes-Browne, *op. cit.*, p. 62.

CHAPTER V.

CHALK.

MIDDLE CHALK.

The middle stage of the Chalk formation, like the Lower, has its chief development, in a superficial sense, in the eastern part of the district, where its outcrop is marked by an irregular belt of uneven and often strongly-inclined ground, on the eastern slope of the Alton-Hills upland. It appears also in the valley of the Meon, and in the inlier of Temple Valley and Chilcombe, south-west of Alresford.

As stated in the introductory portion of the last chapter, the Middle Chalk is here mostly soft and white, but has some hard and nodular beds in the lower part and, to a less extent, near its upper limit also. Its thickness appears to be about 200 feet.

The base of the *Rhynchonella cuvieri* Zone is, as usual, sharply defined by the contact of the hard and nodular Melbourn Rock with the soft Plenus Marl: the upper limit, if anywhere exposed, has not been recognized in the present area, for the alternating hard and firm beds which overlie the Melbourn Rock are succeeded by a soft, blocky chalk, in which distinctive fossils are so scarce as to make the identification of the base of the overlying zone well nigh impracticable in such small sections as the district at present affords. Remains of *Inoceramus mytiloides* Mant. (= *I. labiatus* Schloth.)—the most characteristic of the commoner fossils of the Cuvieri Zone—are, however, usually to be found up to about 40 feet above the *Act. plenus* Marls; and 60 feet is a probable estimate of the full thickness of the lower zonal division of the Middle Chalk. A few flints were seen in this zone, near Chawton.

The Zone of *Terebratulina lata* (or *T. gracilis* var. *lata*) is composed, in the main, of soft to firm white chalk, usually of rather coarser texture than that of the Cuvieri Zone, and more boldly jointed. In the upper part (within about 40 feet of the top) thin, persistent layers or seams of laminated grey marl are a conspicuous feature, the chalk between them containing ill-defined bands of a lumpy or nodular character, and a few definite, thin beds of hard, nodular or homogeneous limestone of rusty tint. Here, too, small spheroidal and "horned" nodules of flint, with thin rinds or cortices, occur diffusedly, and, less often, in indistinct open courses, parallel with the seams of marl.

The thickness of the *Terebratulina* Zone is estimated at 120 to 140 feet.

Zone of Rhynchonella cuvieri.

To commence with the northern sections:—Some small exposures of rough, yellowish Melbourn Rock, and of the lumpy beds (with *Inoceramus mytiloides* Mant.) above it, can be seen in the shallow road-cuttings between 3 and 4 furlongs north-west of Holybourne Church, and between 1 and 2 furlongs north of the parish church at Alton. In the cutting north-west of Holybourne a rough "grit-bed," composed largely of comminuted *Inoceramus*-shell, was observed, a few feet above the Melbourn Rock.

A good section of beds in the lower part of this zone is shown in a small field-pit 250 yards west of Ansty Manor House, west of Holybourne. The chalk here is distinctly stratified; hard beds of a more or less nodular character alternating with beds of greyish-white, obscurely-laminated, marly chalk containing rolled pieces of white chalk. The nodular structure is most marked at the base of the section, which has a depth of 12 feet. The bedding dips 5° north-north-west. *Rhynchonella cuvieri* d'Orb. and *Inoceramus mytiloides* occur in profusion, and with them were found *Discoidea dixonii* Forbes, *Ostrea vesicularis* Lam., *Inoceramus brongniarti* J. de C. Sow., *Haploceras cunningtoni* (Sharpe).

The section of Melbourn Rock seen at the top of the (main) quarry at Wilsham Lime Kilns, in the Middle Chalk outlier east of Alton, has already been noticed (p. 33). A pit to the south of this quarry, and connected therewith by shallow workings now overgrown, shows 15 feet of firm to soft, homogeneous, closely-jointed white chalk, rich in remains of *Inoceramus mytiloides* Mantell. The south-eastward dip which is seen in the main quarry, and which carries the Melbourn Rock below the floor-level of this smaller working, is not appreciable here. Excepting the characteristic *Inoceramus*, fossils are rather scarce: *Camerospongia capitata* T. Smith, *Rhynchonella cuvieri* d'Orb., and *Ostrea vesicularis* Lam. were noted.

Other exposures of beds forming the Alton outlier can be seen in the railway cutting, and in lanes, south-east of the town.

Five furlongs north-west of Chawton House, a pit in a strip of waste-land, beside the London and South-Western (Bentley Branch) Railway, shows 10 feet of ironstained, nodular and flaggy chalk containing a few branching flints with rough grey rinds. The western end of the pit intersects a fault which brings nodular fossiliferous chalk into contact with a closely-jointed homogeneous chalk that yielded only a few bits of *Inoceramus*. In the nodular beds the following were found:—Borings and branching structures, *Nymphaster marginatus* Sladen, *Serpula cincta* Goldf., *Cidaridites hirudo* Sorig., *Conulus subrotundus* Mant. (common), *Membranipora* sp., *Rhynchonella cuvieri* d'Orb., *Terebratulina striata* Dav., *Inoceramus mytiloides* Mant. (very common).

A white chalk, near the top of the Cuvieri Zone, and in which only a few fragments of *Ostrea* and *Inoceramus* were found, is shown in road-banks near the railway-cutting half-a-mile north of Chawton.

Flaggy beds, with *Inoceramus mytiloides*, are poorly exposed below gravelly loam in Brightstone Lane west of Lower Faringdon, and similar chalk, with the same fossil, *Rhynchonella cuvieri*, and *Terebratulina semiglobosa* J. Sow., appears in a road-bank by the wood south-east of New Barn Farm, one mile south of Faringdon.

A fairly clear impression of the general lithological characters of the Cuvieri Beds can be gained from an inspection of the small exposures which occur in the banks of the lane leading from Newton Valence to Hawkey, within half-a-mile of the former village. The Melbourn Rock, which appears at a point a little above the 500-feet contour, is succeeded by about 60 feet of pure-white fine chalk, in which hard, nodular or homogeneous, flaggy beds, a foot or two in thickness, alternate with others merely firm or even soft. The hard beds become less frequent upwards, and at the point (below 600 feet O.D.) where the lane adopts a more northern trend, the fine-grained white chalk gives way to a coarse, blocky, faintly-greyish chalk, like that of the *Terebratulina lata* Zone,

and probably belonging to that division. Remains of *Inoceramus mytiloides* are common in some of the hard beds above mentioned, and *Rhynchonella cuvieri* was noted in the highest of those exposed, but nothing distinctive could be got from the coarse-grained chalk above.

On the north-side of the road from East Tisted to Selborne, at the turning to Shotter's Farm, an excavation for a rain-water tank proved white lumpy and nodular chalk with *Inoceramus mytiloides*, below chalky gravel.

The spread of more or less nodular Cuvieri Beds which caps the Lower Chalk on the summit and western slope of Noar Hill, has been dug in a large number of shallow workings, whose grass-grown hollows and spoil-banks give the back of the down an oddly tumbled appearance. Rubbly Melbourn Rock was noticed near the crest of this hill, and small exposures of nodular beds, all probably in the lower half of the Cuvieri Zone, were seen in the brows of the larger workings on the dip slope. *Inoceramus mytiloides* Mant. is abundant in most of these exposures: the other fossils seen included *Plocoscyphia convoluta* (T. Smith), *Serpula avita* J. Sow., *Rhynchonella cuvieri* d'Orb., *Inoceramus lamarchi* Parkinson.

The small sections of Melbourn Rock at Prior's Dean and to the north-east of Baker's Farm were noticed in the last chapter (p. 35).

The Melbourn Rock and a little of the overlying chalk are poorly shown in road-banks on the eastern slope of Stoner Hill, and at a point 3 furlongs south-west of Staple Ash Farm, south of Froxfield.

Zone of Terebratulina lata.

"The chalk of this zone," writes Mr. Jukes-Browne,* "runs along the slope of the hills north-west of Alton, and may be seen in two small quarries, one by the roadside half-a-mile north of Alton Church, and in another about the same distance north-west of the church, both in soft white chalk without flints." The first of these pits is now obscured, and the second, by the footpath from Alton to Shalden, shows only a foot or so of firm, flaggy, white chalk. Casts of borings, *Terebratulina lata* Eth., *Inoceramus bronngiarti* J. de C. Sow. (common), and *Ostrea vesicularis* were obtained from the latter.

Similar chalk appears in road-banks two-thirds of a mile north-north-west of Holybourne Church.

A coarse and rather lumpy chalk, yielding the species just named, is shown in the weather-stained sides of the cutting on the Basingstoke and Alton Light Railway just north of Warren Farm, south of Shalden.

At the northern end of the next cutting north-west of Warren Farm, and also in the sides of an adjacent cartway, half a mile south-west of Shalden Church, a coarse, greyish, lumpy chalk with a few hard, rusty layers is shown. The fossils obtained from these exposures included:—*Haplophragmium* sp., *Coscinopora quincuncialis* (T. Smith), *Ventriculites radiatus* Mant., *Porosphæra globularis* (Phill.), *Metopaster parkinsoni* (Forbes), *Discoidea dixonii* Forbes, *Holaster* sp. (fragment), *Terebratulina lata* Eth., *Ostrea vesicularis*

* 'Cretaceous Rocks of Britain,' vol. ii., 1903, p. 391.

Lam., *Spondylus spinosus* (J. Sow.). This chalk is close to the upper limit of the Terebratulina Zone, and it is probable that the railway-cutting here is partly in the Zone of *Holaster planus*.

Near Lower Faringdon, a bush-grown pit 400 yards due east of Pies Farm shows, at its lower (southern) edge, about 2 feet of hard, nodular to homogeneous, yellow chalk, full of casts of sponges, notably *Coscinopora quincuncialis* (T. Smith) and *Ventriculites mammillaris* T. Smith. Other fossils observed were:—*Verrucocœlia* sp., *Terebratula semiglobosa* J. Sow. (large), *Inoceramus brongniarti* J. de C. Sow., *Ostrea vesicularis* Lamarck. On the upper or northern side of the pit, and about 8 feet higher than the sponge-bed, there is shown a little soft, white chalk, in which the same species of *Inoceramus* and *Ostrea* occur, and *Terebratulina lata* Eth. is abundant. These beds also are close to the top of the Terebratulina Zone.

Farther south, some exposures of small interest were noted in lane-banks south of Newton Valence and by Shotter's Farm to the west of that village; in a pit one-third of a mile north-east of Warren Corner; in old workings on the top of Wheatham Hill, and in the high bank of the main road (Petersfield-Alton) north of Stoner Hill.

Near Warnford, in the Meon Valley, two good sections were seen by the side of the lane which follows the top of the ridge to the east of the village. One of these—in a cutting on the Meon Valley Railway,* at a spot a little less than 7 furlongs south-south-west of West Meon Church—shows a considerable thickness of firm, white, closely-jointed chalk, with thin layers of light-grey marl, dipping 20° north-eastward. Small Asteroid-ossicles, *Coscinopora quincuncialis* (T. Smith), *Terebratulina lata* Eth., and *Ostrea vesicularis* were found at the edge of the cutting, south of the bridge.

The other section is in a pit on the north side of the lane, at about one furlong east of the main (Gosport) road at Warnford. It shows 35 feet of beds in the highest part of the Terebratulina Zone.† The descending succession is:—

Soil: thin.						Ft.	in.
5.	White chalk; firm, flaggy ...	...	...	...	seen	2	0
4.	Pale-grey, laminated marl ...	...	...	...	...	0	4
3.	White chalk; obscurely-nodular, soft to firm, iron stained at the top, and containing small, brown feebly-phosphatic concretions.						
	Flints occur in small, thin-rinded, elongate, horned, and spheroidal nodules; scattered, and in ill-defined, uneven courses					26	0
2.	Grey, laminated marl ...	...	...	...	...	0	2
1.	White chalk; no flints observed ...	...	...	...	seen	7	0

* Not shown in the current (1905) issue of Sheet 300.

† This section can hardly be other than that which C. Barrois describes in the following words:—"A Warnford, chemin de Heydown barn, craie presque sans silex, 2 à 3 petits bancs sur une épaisseur de 10 mètres; j'y ai trouvé: Ammonites sp., Inoceramus sp., Spondylus Dutempleanus, d'Orb. C'est la zone à *Marsupites*; . . ." ('Recherches sur le terrain crétacé supérieur de l'Angleterre &c.,' 1876, pp. 36, 37.)

The beds dip northward, at 15°.

No fossils were seen in bed (1), or in the marl-seams (2 and 4). In bed (3)—where some of the flints are coated with pyrites, more or less oxidised—the following fossils were found:—*Haplophragmium* sp., *Pentagonaster lunatus* (S. P. Woodw.), *Cidaris serrifera* Forbes, *Serpula ampullacea* J. de C. Sow., *Rhynchonella plicatilis* (J. Sow.), *Terebratula carnea* J. Sow., *Terebratulina lata* Eth. (most common in the upper part of the bed), *Anomia papyracea* d'Orb., *Inoceramus brongniarti* J. de C. Sow., *I. sp.*, *Lima* (*Plagiostoma*) *hoperi* Mant., *Ostrea* cf. *wegmanniana* d'Orb., *O. hippopodium* Nilss., *O. vesicularis* Lam. (very common), *Spondylus latus* (J. Sow.), *S. spinosus* (J. Sow.), *Lamna appendiculata* Agassiz.

In bed (4), the only species noted was *Spondylus spinosus* (J. Sow.), which is there of larger size than in the bed below. Bed (4) occupies but a small area of the face of the pit.

A little rubbly white chalk, probably near the base of the Terebratulina Zone, was seen in a small degraded working low down on the eastern side of Temple Valley, at the spot where a dip (north by east) is marked on the map.

CHAPTER VI.

CHALK.

UPPER CHALK.

This division forms the sub-soil of more than one half of the country represented on the Alresford Sheet of the Geological Survey Map, and in it are carved nearly all the valleys and combs which diversify the western part of that area.

Where most developed it is about 550 feet thick, and is thus the thickest of the Cretaceous Stages which appear at the surface in this district—the Weald Clay, perhaps, excepted.

The Zone of *Holaster planus*, at its base, consists of a group of more or less nodular beds, in which irregular lumps of firm to very hard chalk are mixed with a variable proportion of coarse, gritty, friable chalk, either white, or having a grey tint, due to the presence of clayey matter. Thin beds of hard, yellow to pale buff-coloured chalk, with impressions of sponges, are not uncommon, but none of those observed by the writer could be properly termed "Chalk Rock." The *Heteroceras reussianum* Sub-zone, which usually coincides with the Chalk Rock in places where that limestone is developed, is recognizable near East Tisted in the guise of a comparatively soft chalk, with scattered flints.

Flints occur freely in the local Planus Beds, though, by reason of their small dimensions, thick and often pulverulent rinds, and sporadic distribution, they seldom make much show in the sides of quarries.

No complete section of the zone was seen, nor any clear exposure of its junction with the zone below. A comparison of the fossils, and especially of the *Micrasters*, obtained from scattered sections at divers horizons, suggests 40 feet as the probable thickness of the *Holaster planus* Beds in this part of the country.

Exposures of the Zone of *Micraster cortestudinarium* seem rare. So far as could be seen, it is mainly a white chalk; rather coarse and lumpy in the lower parts; finer, softer, and more homogeneous in the upper parts, and containing thin, yellowish, nodular beds, somewhat harder than the rest.

Flints occur plentifully, and are of larger average dimensions than those in the zone below. They are commonly of a rough and spongy character, and they are, to some extent, arranged in courses as distinct, but not so regular, as those in the overlying *Micraster coranguinum* Zone.

The thickness of the *Cortestudinarium* Zone is not known exactly, but it probably does not exceed 50 feet.

In the Zone of *Micraster coranguinum*, which seems to be about 200 feet thick, most of the chalk is pure-white, soft, and homogeneous; but lumpy beds, of pale yellow or cream tint, occur in the lower parts; while thin, impersistent bands of nodular, iron-stained chalk, and rarer seams of grey marl, appear at various horizons, though mostly in the upper half of the zone.

Flint-nodules are abundant. Commonly rough and cavernous in the lower beds of the zone, they are elsewhere usually solid, with more or less distinctly-banded cortices, of varying thickness. They attain larger dimensions than the flints in other parts of the local

Chalk; and, except in the highest beds, they occur (partly) in regular, strongly-marked courses, which are thoroughly characteristic of the Coranginum Zone in the district under notice.

The salient lithological features of the succeeding Zones of *Marsupites testudinarius* and *Actinocamax quadratus* are noticed in the next chapter (p. 50).

Zone of Holaster planus.

The sections examined by the writer are all situated near the eastern boundary of the Upper Chalk, between Lasham Bottom (near Shalden) and Colemore.

Beginning, as before, on the north:—The highest beds of the Planus Zone are well shown in a small quarry about 50 yards north of the Basingstoke and Alton Light Railway at Lasham Crossing, 5 furlongs east-south-east of Lasham Station. The Chalk here is richly fossiliferous, and the writer is acquainted with no other inland section from which good specimens of *Micraster* (*M. præcursor* Rowe group) can be so readily obtained. The succession shown is:—

	Feet.
Soil; thin turf.	
3. Very hard, cream-coloured chalk	seen 2½
2. Soft to firm, lumpy, coarse-grained greyish chalk, with small flint-nodules, of rounded forms, and possessing thick, sharply defined rinds ... ..	... 8
1. Mixed hard and soft nodular greyish chalk, with flints as in bed (2). Near the (visible) base of this bed is a band (1 foot) of hard, gritty chalk, composed largely of comminuted <i>Inoceramus</i> shell and Echinoderm tests	seen 4

Among the fossils found in beds (1) and (2) were:—*Porosphæra globularis* (Phill.), *P. patelliformis* Hinde, *Ventriculites mammillaris* T. Smith, *V. radiatus* Mant., *Bourgueticrinus ellipticus* (Miller), *Cidaris hirudo* Sorig., *C. sceptrifera* Mant., *Echinocorys scutatus* Leske (gibbous), *Holaster placenta* Agass., *H. planus*? (Mant.), *Micraster cortestudinarium* (Goldf.), *M. præcursor* Rowe, *Serpula cincta* Goldf., *S. gordialis* var. *serpentinus* Schloth., *S. granulata* J. de C. Sow., *Nodelea durobrivensis* Greg., *Proboscina angustata* (d'Orb.), *Reptomultisparsa* sp., *Rhynchonella plicatilis* (J. Sow.), *Terebratulina carnea* J. Sow., *T. semiglobosa*, J. Sow., *Terebratulina striata* Dav., *Inoceramus* sp., *Lima* (*Plagiostoma*) *hoperi* Mant., *Ostrea hippodadium* Nilss., *O. normaniana*? d'Orb., *O. semiplana* Mant., *O. vesicularis* Lam., *Spondylus latus* (J. Sow.), *S. spinosus* (J. Sow.).

The *Micrasters* are of the types characteristic of the upper half of the Planus Zone, with interporiferous areas of 'sutured' form in bed (1), and mostly of strongly sutured to moderately 'inflated' forms in bed (2). In the upper part of the latter bed, however, there is a small proportion of tests possessing distinctly inflated and 'sub-divided' areas.*

Bed (3), at the top of the section, is rather obscured by rain-wash and not readily accessible, but it seems to contain few fossils. The character of the *Micrasters* just below it, however, show that this

* See A. W. Rowe, 'An analysis of the Genus *Micraster*, &c.,' *Quart. Journ. Geol. Soc.*, vol. lv., 1899, p. 494.

hard bed is at or very near the horizon of the similar hard beds which mark the upper limit of the *Holaster planus* Zone in other parts of Hampshire, in Oxfordshire, and elsewhere.

In the higher part of Messrs. Phillips's brickyard, 3 furlongs south-east of Beech Farm, south-west of Alton, a little greyish-white, coarse, lumpy chalk, with thick-rinded, elongate flint-nodules, appears between pipes of stony loam (Clay-with-Flints). The spot referred to is near the top of a ridge which is mapped in part as Upper Chalk, but the writer was unable to satisfy himself that the chalk he saw there was not in the *Terebratulina* Zone. The few fossils found were,—*Bourgueticrinus ellipticus* (Miller), *Terebratula semiglobosa* J. Sow., *Terebratulina lata* Eth., *Inoceramus* (fragments), *Pecten* (*Neithea*) *quinquecostatus* J. Sow., *Spondylus spinosus* (J. Sow.).

Five furlongs north-west of Colemore Church, a hard, nodular chalk, near the middle of the *Planus* Zone, and containing *Micraster cortestudinarium* (Goldf.) and *M. præcursor* Rowe ('sutured'), was noted in the western edge of a cutting on the Meon Valley Railway.*

Greyish and yellowish nodular chalk in the lower part of the zone is exposed in small workings at the southern corner of Stony-brow Wood, at a spot a few yards north-west of the cross-roads north of Colemore Common.† About 12 feet of chalk is shown. Flints are abundant, and are mostly spheroidal and fusiform, with grey, banded rinds. The chalk is not less fossiliferous than that at Lasham Crossing, but whereas the dominant echinoderm in the latter is *Micraster præcursor*, here it is *Holaster planus*. Among the fossils found by Dr. A. W. Rowe and the writer were, *Ventriculites impressus* (T. Smith), *Bourgueticrinus ellipticus* (Miller), *Cyphosoma radiatum* Sorig., *Echinocorys scutatus* Leske (gibbous), *Holaster planus* Mant., *Micraster leskei* Desmoul., *M. præcursor* Rowe (sutured), *Serpula ampullacea* J. de C. Sow., *Proboscina crassa* (Roem.) var. *alectodes* Greg., *Rhynchonella cuvieri* d'Orb., *R. limbata* (Schloth.), *R. plicatilis* (J. Sow.), *R. reedensis* Eth., *Terebratula carnea* J. Sow., *T. semiglobosa* J. Sow., *Terebratulina lata* Eth., *Cardita cancellata* Woods, *Inoceramus brongniarti* J. de C. Sow., *I. sp.*,‡ *Ostrea semiplana*? Mant., *O. vesicularis* Lam., *Plicatula barroisi* Peron, *Spondylus latus* (J. Sow.), *S. spinosus* (J. Sow.), *Pleurotomaria sp.*, *Scaphites sp.*, *Turbo sp.*

In the above list the fauna of the *Heteroceras reussianum* Sub-zone is poorly represented by *Cardita cancellata*, the small, "Chalk Rock" *Inoceramus* (figured by Mr. H. Woods), and *Scaphites* (probably *S. geinitzi* d'Orb.); with *Pleurotomaria* and *Turbo* as accessories. *Micrasters* of the *M. leskei* and the *M. præcursor* groups occur in the proportion of about 4 to 1. *Echinocorys scutatus* seems scarce.

A small exposure of beds above the middle of the *Planus* Zone was seen in a degraded pit (by the Meon Valley Railway) 100 yards

* At the spot where the railway intersects the lane (now in part diverted) leading from Colemore westward to the Gosport road.

† Mr. C. Griffith states that these are the excavations alluded to in the words "chalk-pit, near Beckstedde Farm," in 'Cretaceous Rocks of Britain,' vol. iii., 1904, p. 58.

‡ Figured by H. Woods in 'The Mollusca of the Chalk Rock: Part II,' *Quart. Journ. Geol. Soc.*, vol. liii., 1897, Pl. xxvii., fig. 14.

south of the house named New Inn* on Sheet 300, west of Colemore Common. The chalk is somewhat nodular or lumpy, and contains hard yellowish bands. Flints are numerous. The fossils seen included:—*Plocoscyphia convoluta* (T. Smith), *Parasmilia centralis* (Mant.), *Echinocorys scutatus* Leske (gibbous), *Holaster placenta* Agass., *Micraster cortestudinarium* (Goldf.), *M. præcursor* Rowe (strongly sutured to slightly inflated areas), *Rhynchonella plicatilis* (J. Sow.).

Zone of Micraster cortestudinarium.

Only two exposures of chalk referable to this zone were observed.

One of them is in the grounds of Rotherfield Park, East Tisted, at a spot 250 yards north-east of Plain Farm. Here a partly overgrown quarry shows about 25 feet of rather coarse, white, lumpy chalk containing many rough thick-rinded flints disposed in irregular bands. The following forms were noticed in the course of a brief inspection of the lower part of the section,—*Hydractinia* sp., *Bourgueticrinus ellipticus* (Miller), *Echinocorys scutatus* Leske (stout gibbous), *Holaster placenta* Agass., *Micraster cortestudinarium* (Goldf.), *M. præcursor* Rowe, *Serpula cincta* Goldf., *Berenicea papillosa* (v. Reuss), *Gargantua hippocrepsis* (Goldf.), *Membranipora elliptica* v. Reuss, *Stomatopora granulata* (M. Edw.), *Inoceramus lamarecki* Parkinson.

The *Micrasters* are of types indicative of the lower part of the zone.

The other exposure is in a small field-pit, half-a-mile north of Lasham Crossing, and about 5 furlongs north-east of Lasham Station, on the Basingstoke and Alton Railway. This shows 10 feet of rather lumpy white chalk, with a few hard, yellowish, ironstained bands in the lower half of the section. Flints are plentiful and of irregular shapes; some are rough and cavernous, and nearly all have thick cortices. Among the fossils noted were,—*Serpula cincta* Goldf., *S. ilium* Goldf., *Micraster cortestudinarium* (Goldf.), *M. præcursor* Rowe.

Micrasters are common about the middle of the section, and are of the types usually found in the upper beds of the *Cortestudinarium* Zone. The top of the chalk shown in this pit is estimated to be about 45 feet higher above Ordnance Datum than the exposure of the hard cream-coloured bed, at or near the upper limit of the Planus Zone, in the pit at Lasham Crossing (*see above* p. 43). In neither pit have the beds an appreciable dip.

Zone of Micraster coranguinum.

The Coranguinum Beds form the higher parts of the Alton-Hills upland, between Shalden and Froxfield, on the east; and much of the broad ridge extending from Wheely Down to Cheesfoot Head, on the south-west. They outcrop on the sides of the Itchen Valley above Bramdean and below Cheriton; also on the northern and eastern slopes of the Alre Basin, and in the Candover Valley, mostly below Swarraton.

The sections noticed in this memoir are dealt with under the following heads,—(a) Bentworth and Medsted; (b) Ropley, East

* An inn no longer.

Tisted, and Privett; (c) Itchen Valley; (d) Candover Valley; (e) West Stratton.

(a). *Sections around Bentworth and Medsted.*—About 1 furlong north of Lasham and Bentworth Station, on the Basingstoke and Alton Railway, a small excavation in a field shows 12 feet of white chalk, near the middle of the Coranguinum Zone. The flints have thick, agate-like rinds, and occur mostly in well-marked courses, which indicate a dip of 5° south-west and a small fault with a downthrow of 2 feet in the same direction. Tests of *Micraster coranguinum* (Leske) are rather common; other fossils noted were,—*Porosphæra globularis* (Phill.), *Spinopora dixonii* Lonsd., *Metopaster parkinsoni* (Forbes), *Stauranderaster bulbiferus* (Forbes), *Serpula ilium* Goldf., *Terebratula semiglobosa* J. Sow., *Inoceramus cuvieri* J. de C. Sow., *Ostrea vesicularis* Lamarck.

One and a quarter miles north-north-west of Bentworth Church, a quarry near the 500-feet contour shows 25 to 30 feet of higher beds, with strongly-marked flint-bands disposed at intervals of about 3 feet. *Micraster coranguinum* (Leske), and *Echinocorys scutatus* Leske of the ovate form characteristic of the Coranguinum Zone, were the most noteworthy of the fossils observed.

A similar chalk, exposed in a pit midway between the quarry just noticed and Powell's Farm, yielded, among other fossils,—*Bourgueticrinus ellipticus* (Miller), *Comulus albogalerus* Leske, *Serpula ampullacea* J. de C. Sow., *Membranipora inornata* (d'Orb.), *Ostrea normaniana* (d'Orb.), *Spondylus latus* (J. Sowerby).

On the east side of the village of Bentworth soft white chalk, with comparatively few layers of flint-nodules and a little tabular flint, is exposed by the roadside (near the "Sun" inn) east-south-east of Summerley Lodge; and in a pit 1 furlong to the east of that house. In both exposures *Comulus albogalerus* Leske and the bryozoon *Truncatula aculeata* (Mich.) are common, the other fossils found including,—*Echinocorys scutatus* Leske (ovate), *Micraster coranguinum* (Leske), *Membranipora elliptica* v. Reuss, *Meliceritites lonsdalei* Greg., *Proborescina elevata* (d'Orb.), *Inoceramus cuvieri* J. de C. Sow., *Ostrea hippopodium* Nils., *Spondylus spinosus* (J. Sowerby).

At Holt End, south of Bentworth, a field-pit about 3 furlongs east of Gaston Grange shows 10 feet of soft beds with thick-rinded flints. Here, also, *Truncatula aculeata* (Mich.) was forthcoming; and an example of *Pachydiscus leptophyllus* (Sharpe) [*Haploceras* Auctt.], apparently about 2 feet in diameter, was seen in section. This chalk probably is close to the top of the Coranguinum Zone. Fossils are scarce.

Half-a-mile west of Bentworth Church about 12 feet of beds in the upper part of the zone are seen at the western end of an old 'dell,' full of trees. The fossils obtained included,—*Pentagonaster quinquelobus* (Goldf.), *Cidaris perornata* Forbes, *C. sceprifera* Mant., *Comulus albogalerus* Leske, *Echinocorys scutatus* Leske, *Micraster coranguinum* (Leske), *Reptomultisparsa congesta* (v. Reuss).

One fourth of a mile north-by-west of Medsted Church a field-pit shows a little flinty chalk, of Coranguinum-Zone aspect, containing *Echinocorys scutatus* Leske, *Berenicea phlyctænosa* v. Reuss, *Onychocella depressa* (v. Hag.) var. *simplex* (d'Orb.).

At Wivelrod, north-east of Medsted, the banks of the western lane on the north-west side of the Alton Road show the weathered edges of perhaps 40 feet of beds, which seem to be at about the same horizon as those exposed near Summerley Lodge, Bentworth (see above, p. 46). Among the fossils noted here were, *Comulus albogalerus* Leske, *Echinocorys scutatus* Leske, *Micraster coranguinum* (Leske), *Terebratulina striata* Davidson.

An old quarry south-east of the house called Roe Downs, south-east of Medsted, gives a clear section, about 20 feet deep, of soft white beds with flints in well-marked bands dipping 5° westward. Small spongy flints, scattered freely through the chalk, draw attention from the calcite fossils; and the latter, when distinguished and removed, proved to be mostly chips of *Inoceramus*. The presence of *Micraster coranguinum* (Leske) ('high zonal'), *Bourgueticrinus ellipticus* (Miller), *Serpula granulata* J. de C. Sow., and *S. ilium* Goldf. can, however, be recorded.

Nearly a quarter of a mile south of Roe Downs there is an old, wooded dell which shows about 25 feet of weather-stained beds, at a lower horizon than the chalk last noticed. Many of the flints, which occur in regular courses, have a pale red-violet tint. Excepting *Porosphæra patelliformis* Hinde, fossils are scarce.

Similar beds, most probably in part on the same horizon, are traversed by the railway cutting north-east of Medsted (or Medstead) Station. Prof. C. Barrois, who examined the cutting when it was fresher, and found no fossils, noted a dip of "4° towards the south, a little west."²

Micraster coranguinum was noted in a small exposure at the cross-roads 3 furlongs south-west of Medsted Station.

Chalk with solid spheroidal and rough thick-rinded flints, in even layers, is exposed in a pit by the footpath from Medsted to Hattingley, at a spot 3 furlongs west of Medsted Church. Few fossils were seen; *Porosphæra globularis* (Phill.), *Micraster coranguinum* (Leske), *Inoceramus cuvieri* J. de C. Sowerby.

By the side of the road running southward from Heath Green, west of Medsted, there are two quarries between 500 and 600 feet O.D. The higher of these shows 12 feet of horizontal beds with irregular bands of flints possessing agate-like rinds, often of a pink to pale violet tint. The flint courses indicate a fault with an unascertained but probably trifling downthrow to the south-west. Fragments of *Inoceramus cuvieri* J. de C. Sowerby are abundant; among other fossils seen were,—*Pentagonaster quingelobus* (Goldf.), *Cidaris scoptrifera* Mant., *Entalophora madreporacea* (Goldf.), and *Ostrea vesicularis* Lamarck.

In the lower quarry, where the road is crossed by a footpath, about 15 feet of chalk, with numerous regular courses of thick-rinded flint-nodules and some tabular flint, is exposed. Here the bedding has a slight westward dip. Tests of *Echinocorys scutatus* Leske, of ovate form and mostly thin, are common in the lower part of the section, and are associated with *Conulus albogalerus* Leske, *Micraster coranguinum* (Leske), and *Inoceramus cuvieri* J. de C. Sowerby.

In the country west and south-west of Medsted other exposures, yielding a few common fossils, were noticed by the roadside to the south of Armsworth House; east-north-east and south of Breach Farm; and south of Lower Soldridge Farm.

(b.) *Sections near Ropley, East Tisted, and Privett.*—One third of a mile north-west of Bottom Farm, south-east of Ropley, a small trench-like pit by the roadside shows a few square feet of a rather coarse, yellowish chalk, from which Dr. A. W. Rowe and the writer obtained,—*Asteroidæ*, *Cidaris clavigera* Koenig, *Conulus albogalerus* Leske (common), and a few other fossils.

A pit one fourth of a mile north of Jews Wood Farm, west of East Tisted, exposes 20 feet of beds in the lower part of the Coranguinum Zone. The chalk is rather lumpy and ironstained in places, and contains many thick-rinded flint nodules of a cavernous and 'mealy' type, together with thin tabular seams and veins of pale-violet flint. Notable features of this chalk are the prevalence of broad, thin shards of *Inoceramus*-shell (*I. cuvieri* J. de C. Sow.), disposed along and athwart the bedding planes, and the unwonted frequency of *Pecten* (*Chlamys*) *cretosus* DeFrance. To judge from the small samples taken, the 'meal' in the hollows of the flints is rich in remains of micro-organisms (Foraminifera, sponge-spicules, Bryozoa). Among the other fossils found were,—*Haplophragminum* sp., *Webbina* sp., *Ventriculites cribrosus* Phill., Asteroid-ossicles (small), *Cidaris clavigera* Koenig, *C. perornata* Forbes, *Echinocorys scutatus* Leske (gibbous), *Micraster coranguinum* (Leske) ('high zonal type'), *Berenicea canui* Greg., *Entalophora echinata* (Roem.), *Nodelea durobrivensis* Greg., *Crania egnabergensis* Retz. *Rhynchonella reedensis* Eth., *Terebratulina striata* Dav., *Spondylus latus* J. Sowerby.

About 20 feet of chalk much like that just noticed, but less fossiliferous, is shown in a bushy 'dell' nearly one-third of a mile south-south-west of Bower Farm, north-west of Froxfield. The fossils noted here included,—*Idmonea alipes* Greg., *Membranipora santonensis* (d'Orb.), *Nodelea durobrivensis* Greg., *Terebratula semiglobosa* J. Sow., *Inoceramus cuvieri* J. de C. Sow. (abundant). This chalk may be near the junction with the Cortestudinarium Zone.

Road-banks about 200 yards south-south-west of Privett Church give a small exposure of one of the hard, yellowish, nodular bands which are occasionally developed in the upper part of the Coranguinum Zone. No megascopic fossils were seen. Hollow moulds of sponge-spicules are discernible in this chalk, with a lens.

A recently-worked quarry 300 yards south-west of Privett Church, and at a lower level than the last exposure, shows 15 feet of soft white chalk with

* 'Recherches sur le terrain crétacé supérieur de l'Angleterre, &c.,' 1876, p. 45 and fig. 5.

greyish, thick-rinded flints in regular courses dipping (approximately) southwards at 2° to 3° . The most conspicuous fossils here are *Comulus albugalerus* Leske, and *Echinocorys scutatus* Leske (ovate), which are generally in good preservation.

A very soft white chalk, with few scattered grey flints, and probably close to the summit of the zone, is exhibited in an old working one-third of a mile north-east of Stock Farm, west of Privett. Fossils seem scarce: *Porosphæra patelliformis* Hinde, *Echinocorys* (fragments), *Micraster coranguinum* (Leske), *Inoceramus* (small bits), *Ostrea vesicularis* Lamarck only were observed.

The pit at the spot where a dip of $2\frac{1}{2}^{\circ}$ (south-westward) is marked on the map, south of Stock Farm, is now quite degraded.

(c.) *Sections in the Itchen Valley.*—The position of the sections near Privett, noticed above, and the low inclination of beds near Privett Church and south of Stock Farm, make it well-nigh certain that much of the upper part of the Itchen Valley (Bramdean Bottom) is cut in the Coranguinum Zone, though the writer saw no good exposures between Lower Bordean and Hinton Ampner. About Hinton Ampner and Cheriton the lower beds of the Marsupites Zone come down into the bottom of the valley, but the Coranguinum Chalk reappears near North End, and about 15 feet of its upper beds are shown in a small pit at Cheriton Mill. Here the chalk contains many large, thick-rinded flint-nodules, both scattered and in strongly marked courses; and it yielded,—*Spinopora dizoni* Lonsd., *Asteroid-ossicles*, *Bourgueticrinus ellipticus* (Miller), *Comulus albugalerus* Leske, *Micraster coranguinum* (Leske), *Crania egnabergensis* Retz., *C. parisiensis* Defr., *Thecidium wetherelli* Morris, *Dimyodon nilssoni* (v. Hag.), *Ostrea vesicularis* Lamarck.

Lower beds, of rather coarse texture, and containing many large flints, are dug in a pit by the roadside 3 furlongs south-east of Tichborne Church. *Inoceramus curvieri* (fragments of which abound), *Terebratulina* aff. *carnea* J. Sowerby, and *Ostrea* were the only fossils observed.

On the ridge south of Grange Farm, Tichborne, a disused quarry shows about 20 feet of sparingly flinty chalk, having a slight southward dip. The lower part of the section exhibits one well-marked and other less distinct bands of thick-rinded flints. Near the middle is a thin, continuous seam of grey marl, above which the flints are mostly small and scattered, or in open bands. An impersistent band of iron-stained nodular chalk, from 1 to $1\frac{1}{2}$ feet thick, appears in the upper part of the section. The following were obtained from chalk within a distance of about 4 feet above and below the seam of marl,—*Porosphæra globularis* (Phill.) large, *P. nuciformis* Hinde, *Bourgueticrinus ellipticus* (Miller) and granulate variety, *Stauranderaster ocellatus* (Forbes), *Micraster coranguinum* (Leske), *Micropora confluens* (v. Reuss), *Stomatopora granulata* (M. Edw.), *Crania egnabergensis* Retz., *Terebratulina striata* Dav., *Dimyodon nilssoni* (v. Hag.), *Inoceramus* (fragments common). The writer is doubtful as to the horizon of this chalk, but would refer it, provisionally, to the highest part of the Coranguinum Zone.

In a small roadside pit east of the cross-roads half-a-mile east of Ovington Church *Echinocorys scutatus* Leske, of a form between ovate and pyramidal, was observed, with a few common Upper Chalk fossils, in a soft chalk which also probably is close to the upper limit of the zone.

Lower beds, with *Micraster coranguinum* and other common forms, are seen in the river-bluff east of Ovington; and from this village westward, to Winchester, excavations in Coranguinum Chalk, with many flints, occur at short intervals on both sides of the Itchen Valley. Of such of these pits as lie within the area of Sheet 300, mention may be made of one, in the steep southern slope of the valley, a little west of Ovington; a second, in a farmyard 1 furlong south-west of Ovington Church; a third, west of Itchen Abbas Church; a fourth, by the railway bridge north of Chilland; and a fifth, about a quarter of a mile north-west of Itchen Abbas Station. The writer visited some of these in company with Dr. A. W. Rowe, but nothing of interest was observed, save in the third, which is in a garden by the river, 150 yards south-west of Itchen Abbas Manor Farm.

Here the chalk—of which about 15 feet is shown—has a yellow tinge, and contains, near the base of the section, some thin yellow, obscurely-nodular bands. Flints are plentiful in solid nodules of the ordinary Coranguinum Zone types, but the chalk as a whole resembles that commonly found in the Zone of *M. cortestudinarium*. The fossils noted were,—*Ventriculites radiatus* Mant.,

Asteroidea, *Echinocorys scutatus* Leske (ovate), *Micraster coranguinum* (Leske), *Terebratula carnea* J. Sow. (common), *Inoceramus cuvieri* J. de C. Sowerby. The two examples of *Micraster* found were of 'high zonal' type, indicative of a horizon well above the base of the Coranguinum Zone.

Although no sections in this zone were found in the country south of the Itchen Valley, there is reason to believe that it has a considerable development at the surface in the high ground about Cheesefoot Head, Lane End Down, and Preshaw Farm.

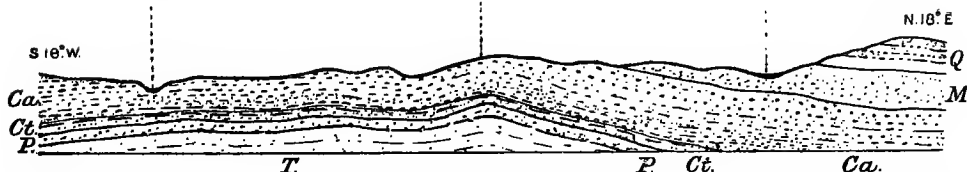
(d.) *Sections in the Candover Valley.*—The Coranguinum Beds outcrop in an irregular strip of ground extending up this valley, from its lower end, near Itchen Stoke, to Totford.

Near the bridge at Abbotstone, and on the east side of the stream, a pit shows about 12 feet of chalk with many flint-nodules (some of large size) in regular courses which have a faint inclination towards the south. Fossils: *Porosphæra globularis* (Phill.) *Asteroidea*, *Echinocorys scutatus* Leske (large, ovate), *Micraster coranguinum* (Leske), *Stomatopora granulata* (M. Edw.), *Inoceramus* (common).

FIG. 10 —Section from Abbotstone to Brown Candover.

Distance $4\frac{1}{2}$ miles. Vertical Scale, about 1 inch = 600 feet.

Abbotstone. near Swarraton. Brown Candover.



Chalk Zones:—*T.* *Terebratulina*, *P.* *Hol. planus*, *Ct.* *M. cortestudinarium*, *Ca.* *M. coranguinum*, *M.* *Marsupites*, *Q.* *Act. quadratus*.

Another pit at Abbotstone, in the north-east corner of the farmyard, exposes 10 feet of chalk abounding in small spheroidal, spongy flints, besides the ordinary solid nodules, which are present mostly in regular bands. A rusty, yellowish sub-nodular bed, about 1 foot thick, is shown in the upper part of the section. Fossils are scarce: *Plinthosella squamosa* Zittel, *Onchotrochus serpentinus* Dunc., *Bourgueticrinus ellipticus* (Miller).

About half-a-mile south of Swarraton a road-cutting on the east side of the valley gives a clear section of about 50 feet of beds, rich in flints and poor in fossils. For approximately two-thirds of the section, reckoning from its lower (northern) end, the flints are generally large, thin-rinded, and arranged in clearly-defined courses. Towards the upper end they are comparatively small, have thicker rinds, and are disposed in a less orderly manner. Solid 'cannon shot' nodules are common.

The bedding is slightly undulate, with a prevailing dip of 1° to 2° southward. Near the middle of the section there are two parallel faults, each with a northward down-throw of 2 feet. *Bourgueticrinus ellipticus* (Miller), *Metopaster uncutus* (Forbes), *Micraster coranguinum* (Leske), and *Terebratula carnea* J. Sowerby were noted in the middle beds.

North of Swarraton the chalk has a northward dip, which carries the Coranguinum Zone, and most of the Marsupites Zone, below the floor of the valley about Brown and Chilton Candover (fig. 10).

(e.) *Section near West Stratton.*—In the north-western part of the district only one exposure of beds referable to the Coranguinum Zone was observed.

Three furlongs north-west of Parkhill Farm a shallow, degraded field-pit shows a little chalk which is probably in the highest part of the zone. The few fossils seen were, *Bourgueticrinus ellipticus* (Miller), *Conulus albogalerus* Leske, *Echinocorys scutatus* Leske (large ovate form, cf. *E. striatus* Wright), *Pecten* (*Neithea*) *quinquecostatus* J. Sowerby.

CHAPTER VII.

CHALK.

UPPER CHALK, *continued*.

The zonal divisions which remain to be considered are those of *Marsupites testudinarius* and *Actinocamax quadratus*.

The former is here a pure white, homogeneous and soft chalk, of very fine texture except for occasional thin gritty seams, rich in fragments of echinoderms. Flint-nodules, though usually plentiful, are less abundant than in the Coranguinum Beds, while their smaller size and more sporadic distribution render them much less conspicuous in sections. They are mostly black, with sharply-defined, thick, white or grey cortices, in the lower half of the zone; grey, with thinner rinds, in the upper. Greyish tabular flint is frequently met with, in thin seams following the bedding, and in oblique veins; and small, almond-shaped lenticles are especially noticeable in the upper beds of the Marsupites Zone.

The thickness of this zone hereabouts appears to be 120 to 130 feet, of which about one-half is referable to the lower Sub-Zone, or Uintacrinus Band. The Marsupites Band is, as usual, divisible into two parts; a lower and thicker part, in which *Marsupites testudinarius* Schloth. is of common occurrence; and an upper, about 20 feet thick, in which remains of this crinoid are either wanting or exceedingly scarce, and in which the markedly pyramidal or angulate shape-variations of *Echinocorys scutatus*, characteristic of the middle and lower portions of the Marsupites Zone, are largely replaced by smaller, depressed pyramidal and sub-gibbous forms. In the area of the Basingstoke Sheet (No. 284) of the Geological Map, immediately to the north of the Alresford district, the upper division of the Marsupites Band is further distinguished by the presence of *Actinocamax granulatus* (de Blainville)*—a belemnoid which is seldom found, either at this or any other horizon of the Chalk, in the country to which the present memoir relates.

The Zone of *Actinocamax quadratus*, which measures about 400 feet at the eastern end of the Isle of Wight, has been estimated to be at least 200 feet thick in the central parts of Hampshire.†

In the area of the Alresford Sheet the highest beds seem nowhere to be present, and it is doubtful whether the local Chalk referable to this zone anywhere attains a greater thickness than 150 feet.

The Quadratus Chalk is, for the most part, as purely white and of as fine a texture as that in the Marsupites Zone. The flints are generally of shapes which may be described as sub-cylindrical, fusiform, and sub-spherical. A large proportion of them are more or less distinctly grey throughout. The blacker sort, as a rule,

* See 'Geology of the Country around Basingstoke' (*Mem. Geol. Survey*), 1909, p. 30.

† A. J. Jukes-Browne, 'Cretaceous Rocks of Britain' (*Mem. Geol. Survey*), vol. iii., 1904, p. 58.

have thick white or grey rinds, but in some cases the cortex is reduced to a mere film. Exteriorly, many of the nodules are of a pale yellow or fawn colour.

The proportion of flints present varies greatly; some sections showing hardly any of these nodules; others exhibiting definite, parallel courses, which, however, are seldom so distinct as those in the Coranguinum Beds.

A few thin, persistent marly seams were observed, at some distance above the base of the zone.

Zone of Marsupites testudinarius.

The sections to be noticed will be dealt with under the following headings,—(a) West of the Candover Stream; (b) Bradley and Wield; (c) Ropley and West Tisted; (d) West Meon; and (e) Cheriton.

(a.) *Sections West of the Candover Stream.*—The Marsupites Zone, with an irregular capping of higher beds, forms the rolling country on either side of this stream in its course from Preston Candover to Swarraton. No exposures were found on the flaring eastern side of the Candover Valley, but on the stronger slope to the west of the brook chalk belonging to the Marsupites and Quadratus Zones was seen in several places.

Three furlongs north-west of the church at Preston Candover a quarry shows 20 feet of soft chalk with many small nodules, and some seams, of grey flint. Remains of *Marsupites testudinarius* Schloth. occur throughout the section; other fossils observed were,—*Bourgueticrinus ellipticus* (Miller), *Metopaster uncatus* (Forbes), *Echinocorys scutatus* Leske (pyramidate and depressed ovate forms), *Rhynchonella plicatilis* (J. Sow.), *Terebratula carnea* J. Sow., *Ostrea hippopodium* Nilss., *O. vesicularis* Lam., *O. wegmanniana* d'Orbigny.

Beds with *Marsupites testudinarius* show in a lane-bank one-fourth of a mile west of Chilton Candover, and pyramidate *Echinocorys scutatus* occurs in the lowest of a series of small exposures by the side of the road leading from Brown Candover to Lone Farm, at a spot approximately a quarter of a mile south-west of Brown Candover Church.

In the banks of the roads which ascend the slope west of Totford and of Swarraton there are small exposures of chalk referable in part to the Uintacrinus Band, in part to the highest beds of the Coranguinum Zone.

On the high ground to the west of the Candover Valley chalk of the Marsupites Band is dug in two pits, about 10 feet deep, situated respectively one-fourth and two-thirds of a mile due west of Northington Church. In both sections the chalk contains thick-rinded black and grey flints, mostly of small size, and the following fossils,—*Porosphaera globularis* (Phill.), *Bourgueticrinus ellipticus* (Miller), *Marsupites testudinarius*, *Echinocorys scutatus* Leske, *Micraster coranguinum* (Leske).

Chalk which appears to be at the junction of the Marsupites and Quadratus Zones is poorly exposed in a degraded field-pit near the 400-feet contour 3 furlongs west-north-west of Lone Farm, 2½ miles west of Preston Candover. It contains comparatively few thick-rinded black flints, and some small grey flints of sub-spherical shape. The few fossils obtained comprised,—*Porosphaera patelliformis* Hinde (large), *Marsupites testudinarius* Schloth. (1 plate, ornate type), *Echinocorys scutatus* Leske (fragmentary), *Offaster pillula* (Lam.) (one), *Salenia granulosa* Forbes. The example of *Offaster pillula* and the plate of *Marsupites testudinarius* were found in different parts of the pit, but, so far as could be judged, their respective horizons were not more than 5 feet apart.

(b.) *Sections near Bradley and Wield.*—From the line of the Candover Stream the chalk of the Marsupites Zone extends eastward as far as Bentworth, and it is not unlikely that the lower beds of the Uintacrinus Band occur beneath the western part of that village.

A few ledges of chalk, with *Marsupites testudinarius*, project through the turf on the side of an old pit a quarter of a mile west of Ashley Farm, west of Bentworth.

The highest beds of the Marsupites Band are shown, to a depth of 20 feet, in a roadside pit on the 500-feet contour a quarter of a mile north of Lower Wield. Remains of *Marsupites testudinarius* occur in the lower part of the section, but are rare. Tests of *Echinocorys scutatus* Leske are more easily obtainable, and exhibit the depressed pyramidal and sub-gibbous shapes characteristic of this horizon. Among other fossils obtained were,—*Porosphæra nuciformis* Hinde, *Stauranderaster ocellatus* (Forbes), *Micraster coranguinum* (Leske) var. *laticor* Rowe, *Cidaris hirudo* Sorig. *C. sceptrifera* Mant., *Onychocella lamarecki* (v. Hag.), *Proboscina radiolitorum* (d'Orb.), *Kingena lima* (Defr.), *Pollicipes glaber* Roemer.

Shallow sections in the Uintacrinus Band are shown in the banks of the road just south-west of Barton Copse, south-west of (Upper) Wield. The chalk, which contains scattered black flints with thick rinds, is, for the most part, soft and but poorly fossiliferous; but here and there are thin gritty bands, abounding in ossicles of *Uintacrinus* sp., *Bourgueticrinus ellipticus*, and asteroids (including *Pentagonaster quinquelobus*), together with chips of *Echinocorys* and *Inoceramus*.

A little soft chalk, probably in the upper part of the Marsupites Band, was seen in a degraded working on the Bogmoor Hill ridge, at a point two-thirds of a mile north-east of Swarraton Farm. The fossils noted here included *Stauranderaster ocellatus* (Forbes), *Echinocorys scutatus* Leske (pyramidal), *Pecten* (*Chlamys*) *cretosus* DeFrance. A good example of *Echinocorys scutatus*, of the acutely-angulate form often seen in the Uintacrinus Band in Hampshire, was observed in a rabbit-burrow on the slope to the south-east of this pit, at a lower level by about 40 feet.

(c.) *Sections near Ropley and West Tisted*.—The chalk referable to the Marsupites Zone in the neighbourhood of these villages appears to be completely separated from the northern development about Wield and the Candovers by an irregular belt of what may be termed 'Coranguinum' country, extending from the Itchen Valley near Itchen Stoke north-eastwards, by Brighton, to the main water-parting of the district, between Medsted and Ropley Soke. The Bentley and Alton Branch of the London and South-Western Railway crosses this belt obliquely to the south-west of Medsted, and when travelling by this line from Medsted Station to Alresford, those who have an eye for the cuttings will not fail to observe the decrease in the proportion of flints in the neighbourhood of Ropley Station, where the railway enters the southern area of Marsupites Beds.

Prof. C. Barrois, who remarked the comparative scarcity of flints in the cuttings at Ropley, and thence westward, as far as Alresford, assigned the chalk there exposed to his "*zone à Marsupites*,"* but it remained for Messrs. C. Griffith and R. M. Brydone to prove the presence of *Marsupites testudinarius* itself in these sections.†

At Swelling Hill, north-east of Ropley, a road-cutting, above 500 feet O.D., south of Old Down Wood, shows small sections of soft white chalk with scattered black flints possessing rather thin rinds. About 50 feet of chalk is accounted for in these sections, and almost all of it is in the Uintacrinus Band. Remains of *Uintacrinus*, associated with *Porosphæra globularis* (Phill.), *Bourgueticrinus ellipticus* (Miller), and pyramidal *Echinocorys scutatus*, were noted at intervals throughout the combined section; and in the highest exposure on the north side of the roadway (a small excavation with a face about 5 feet in height) remains of both *Uintacrinus* and *Marsupites testudinarius* were found, together with *Porosphæra globularis* of large growth, *Parasmilia centralis* (Mant.), and *Rhynchonella plicatilis* (J. Sow.), also of large size. This was the sole exposure of the passage beds of the Uintacrinus and Marsupites Bands that the writer saw in the district.

Chalk with *Uintacrinus* is shown in two pits in the sharply-cutcombe of Monkwood, about a mile south-east of Ropley Church. In one of these,

* '*Recherches sur le terrain crétacé*,' &c., 1876, p. 46.

† See A. J. Jukes-Browne, '*Cretaceous Rocks of Britain*,' vol. iii, 1904, p. 62.

situated in the yard of Monkwood Farm, in the bottom of thecombe, Dr. A. W. Rowe noted, among other things, an example of the "nipple-shaped" *Bourgueticrinus*, characteristic of the Marsupites Zone. The other pit—the lower of two excavations* by the Petersfield road, on the north side of thecombe—shows about 20 feet of blocky beds with scattered flints; and yielded (to Dr. Rowe and the writer) about a dozen fossil species, including *Uritacrinus*.

The upper pit by the Petersfield road at Monkwood, between 20 and 30 feet higher than the top of the section last noticed, displays about 12 feet of the Marsupites Band, containing irregular courses of flints with thick grey rinds. Here Dr. Rowe and the writer found upwards of 20 species, including the common *Porosphæra*, *Paramilia contralis* (Mant.), *Marsupites testudinarius*, *Echinocorys scutatus* (common).

Chalk with *Uritacrinus* shows in a road-bank one-third of a mile south-east of Bottom Farm, and *Marsupites testudinarius* was noted by Dr. Rowe in a small field-pit, at a higher level, 100 yards to the south-east of this exposure.

A good section in the Marsupites Band is afforded by a small quarry, about 20 feet deep, by the western side of the road leading from Ropley to West Tisted, at the bend 3 furlongs north-north-west of West Tisted Church. Rather small elongate and horned nodules of grey and black flint are plentiful, and occur partly in indistinct horizontal layers. The southern face of the quarry is in the plane of a strong master-joint, which strikes north-west. Among the fossils seen by Dr. Rowe and the writer were,—*Marsupites testudinarius* (Schloth.), *Rhynchonella plicatilis* (J. Sow.) (large), *Ostrea wegmianiana* d'Orb., *Corax falcatus* Agassiz (tooth).

Part of the Marsupites Band is exposed 1 furlong south-west of the cross-roads at the western corner of Bramdean Common; and, at a lower level, to the north of Old Park Wood, in a quarried road-cutting between one-half and three-quarters of a mile south-east of Manor Farm (Bishop's Sutton). Here many of the flints scattered through the chalk have a dull red, carnelian tint. Scutes of *Marsupites* are common, and pyramidal tests of *Echinocorys scutatus* are plentiful, a well-marked band of the latter occurring near the middle of the section. Bryozoa—e.g., *Membranipora elliptica* v. Reuss, *Onychocella depressa* (v. Hag.)—*Porosphaera globularis* (Phill.), and bits of *Inoceramus* also are common, but few other fossils were noticed.

The ridge which extends from West Tisted to the confluence of the Alre and the Itchen is largely composed of the Marsupites Zone, with a capping of newer chalk about Tichborne Down.

(d.) *Sections near West Meon*.—The Zone of *Marsupites testudinarius* is well developed in the country south of the Itchen Valley and of its normally-waterless upper section, known as Bramdean Bottom. This chalk occurs in the ridge which separates Bramdean Bottom from the Meon Valley, and in the step-like continuation of that ridge about Kilmeston and Gander Down. It outcrops also low down on the southern side of the Meon Valley at West Meon, and is inferred to do so on the slopes about Dur Wood and Longwood House, in the south-western part of the district under notice.

On the eastern side of the grounds of Bereleigh House, about midway between West Meon and Langrish, a shallow road-cutting in the northern slope of the Meon Valley shows 50 feet of beds in the Marsupites Band. Grey and black flints, with thick cloudy rinds, are fairly plentiful, and occur partly in distinct courses, which show no appreciable dip. Plates of *Marsupites testudinarius* (mostly of 'ornate' type) are present throughout the section.

Twelve feet of chalk in the same Band is shown in a road-side pit one-fourth of a mile west of Westbury House, east of West Meon. Here the flints in many cases are grey and of globular form. The single distinct flint-course seen has an inclination of 3° to 5° in a direction slightly east of south—an inclination which is shared by a band of chalk, rich in remains of *Marsupites testudinarius*,

* Mr. C. Griffith tells the writer that these are the two pits whose position is given incorrectly as "nearly 3 miles south-east of Ropley Church" in 'The Cretaceous Rocks of Britain,' vol. iii, p. 62.

exposed in the lower part of the section.* The fossils seen include,—*Metopaster uncatus* (Forbes), *Stauranderaster bulbiferus* (Forbes), *Conulus albogalerus* Leske, *Echinocorys scutatus* Leske (pyramidate).

About 70 yards south-south-east of the pit just noticed, and between 10 and 25 feet higher than the top of that excavation, a road-bank shows chalk containing well-preserved tests of *Echinocorys scutatus* Leske, of the depressed and sub-gibbous forms characteristic of beds about the junction of the Marsupites and Quadratus Zones.

These beds (at the top of the Marsupites Zone) were recognized also in small roadside exposures about 300 yards north of Westbury House.

(e.) *Exposure near Cheriton*.—The writer saw only one exposure of chalk certainly referable to the Marsupites Zone in this neighbourhood. It is situated in an abandoned hollow road running parallel with, and a few yards north of, the highway from Bramdean to Winchester, west of Hinton Marsh. The chalk exposed in the sides of this track, above the 300 feet contour line, belongs to the Zone of *Actinocamax quadratus*; below this line, at a spot about midway between it and the cross-roads at Hinton Marsh, remains of *Marsupites testudinarius* are readily procurable.

Zone of Actinocamax quadratus.

In this case the sections will be grouped under the following geographical heads—(a) The Strattons and the Candovers; (b) Wield; (c) Ropley and Bishop's Sutton; (d) West Meon, Kilmeston, and Cheriton; and (e) Baybridge.

(a.) *Sections near the Strattons and the Candovers*.—The course of the Candover Stream between Preston Candover and Totford roughly marks the eastern boundary of a large outlier (or group of outliers) of Quadratus Chalk, which is partly without the limits of the district covered by Sheet 300, and which includes the developments about Weston and Sutton Scotney,† in the area of Sheet 299 of the one-inch Geological Survey Map.

At the northern end of West Stratton a small road-side pit, about 3 furlongs south-west of Parkhill Farm, shows 8 feet of dirty, iron-stained chalk with scattered nodules and a few thin seams of grey flint. Tests of *Offaster pillula* (Lam.) and the gibbous, flat-based form of *Echinocorys scutatus* Leske—two eminently characteristic echinoids of the Quadratus Zone—are fairly common; the other fossils observed being,—*Porosphæra nuciformis* Hinde, *Clausa globulosa* (d'Orb.), *Onychocella lamarcki* (v. Hag.), *Rhynchonella reedensis* Eth., *Ostrea vesicularis* Lamarck.

From soft speckled chalk, with small sub-spherical and fusiform flints almost destitute of cortex, seen in contact with the Reading Beds in the brickyard at East Stratton (see below, fig. 11, p. 67), the writer obtained,—*Porosphæra patelliformis* Hinde, *Spinopora dixonii* Lonsd., *Bourgueticrinus ellipticus* (Miller) (dumb-bell shaped ossicles), *Metopaster parkinsoni* (Forbes), *Stauranderaster bulbiferus* (Forbes), *Cyphosoma* sp. (radioles, common), *Echinocorys scutatus* Leske (gibbous), *Vincularia* cf. *longicella* d'Orb., *Ostrea lateralis* Nilss. (striate variety),‡ *Spondylus latus* (J. Sowerby).

* A north-westward dip is marked on the map at or near this spot.

The writer does not know on what grounds a tract of Middle Chalk has been mapped in the lateral valley south-west of Westbury House, in Sheet 300. The occurrence of Middle Chalk at the surface in such a position is unlikely.

† See note by C. Griffith in 'Cretaceous Rocks of Britain' (*Mem. Geol. Survey*), vol. iii, 1904, p. 190.

‡ The form called "*Ostrea lateralis* var. *striata* Nils." by A. W. Rowe ('Zones of the White Chalk of the English Coast,' *Proc. Geol. Assoc.*, vol. xvi., 1900, p. 364, and vol. xx., 1908, p. 312.) The varietal name appears not to be Nilsson's.

This little oyster is seldom found outside the Quadratus Zone, and appears to be thoroughly characteristic of that zone around Alresford and Winchester.

South-west of East Stratton, a pit on the west side of the Winchester-Basingstoke road, by the turning to Cow Down Farm, shows about 15 feet of soft, white beds with few flints. Fossils are scarce; *Hydractinia* sp., *Echinocorys scutatus* Leske (small, gibbous), *Ostrea vesicularis* Lam., *Pecten* (*Neitheia*) *quinquecostatus* J. Sowerby.

Shallow sections are seen in the banks of the two lanes which run north-westward from the high road at Chilton Candover. The north-eastern lane shows, in all, about 50 feet of soft, flaggy chalk with thick-rinded flints of elongate and spheroidal shapes. Most of the chalk here seems barren of fossils, but near the point where the track crosses the contour of 500 feet there appear some beds rich in *Onychocella lamarki* (v. Hag.), with which are associated, — *Parasmilia centralis* (Mant.), *Cidaris hirudo* Sorig., *Echinocorys scutatus* Leske (small, gibbous), *Offaster pillula* (Lam.), *Serpula plexus* J. de C. Sow., *Rhynchonella plicatilis* (J. Sow.), *Ostrea lateralis* Nilss., *Spondylus dutempleanus* d'Orb., *S. spinosus* (J. Sowerby).

In the south-western lane—mentioned above (p. 51) as showing chalk with *Marsupites testudinarius* near its lower end, one-fourth of a mile west of Chilton Candover—there are many small sections; some certainly, others probably, in the Zone of *Actinocamax quadratus*. Among the few fossils seen were, — *Echinocorys scutatus* Leske (gibbous), *Cribrilina simplex* (d'Orb.), *Pollicipes glaber* Roemer.

West and south-west of the church at Brown Candover the banks of the road leading from this village to Lone Farm (and Woodmancott, Sheet 284) afford shallow sections of weathered beds in the highest part of the *Marsupites* Band (see p. 51), and in the lower part of the *Quadratus* Zone. In all, about 50 feet of the Chalk is accounted for. *Echinocorys scutatus* was the only kind of fossil seen in the course of a rapid inspection of these exposures, but the examples of this echinoid noted well displayed the shape-variations distinctive of the horizons there represented.

Half-a-mile south-west of Brown Candover Church, a pit by a cart-track shows 12 feet of chalk with scattered, small, black and grey flints; the grey sort being mostly of sub-spherical form and spongy. This chalk also is in the lower part of the *Quadratus* Zone. The fossils found included, — *Porosphera nuciformis* Hinde, *Echinocorys scutatus* Leske (gibbous, and squat pyramidal), and *Offaster pillula* (Lam.).

(b.) *Sections near Wield*.—The low ridge supporting Wield and Lower Wield is partly composed of an outlier of *Quadratus* Chalk, which probably extends south-westward from the former village, along the summit and northern slope of the bolder ridge of Juniper and Bogmoor Hills.

On the south-western side of the road leading from Lower Wield to the cross-roads half-a-mile south-west of Ashley Farm, a partly-overgrown pit shows a little soft chalk, containing many small grey, and some larger thick-rinded black, flints. Thin oyster-beds, consisting chiefly of clusters of *Ostrea wegmansiana* d'Orb. and *O. vesicularis* Lam., are a notable feature of this section. Some of the other fossils seen were, — *Echinocorys scutatus* Leske (small gibbous), *Onychocella lamarki* (v. Hag.), *Rhynchonella plicatilis* (J. Sow.), *R. reedensis* Eth., *Spondylus latus* (J. Sowerby).

Another exposure, of little interest, was seen in the yard of an ale-house at the southern end of Lower Wield.

The best section observed in this part of the district is provided by a small quarry on the north-eastern side of the road from Wield to Preston Candover, at a spot approximately 5 furlongs north-west of Wield Church. Here are exposed some 15 feet of soft beds with scattered, small, yellow-coated flints, possessing very thick grey rinds. Fossils: *Porosphera globularis* (Phill.) (some large, to 30 mm.), *P. nuciformis* Hinde, *Bourgueticrinus ellipticus* (Miller) (including a calyx of a form characteristic of the *A. q.* Zone), *Stauranderaster ocellatus* (Forbes), *Echinocorys scutatus* Leske (gibbous), *Micraster coranguinum* (Leske), *Rhynchonella reedensis* Eth., Fish coprolites.

Poor exposures of chalk which may belong to the *Quadratus* Zone were noted in road banks on the crest of Bogmoor Hill.

(c.) *Sections near Ropley and Bishop's Sutton*.—In the basin of the Alre there are at least two small outliers of this zone; one of them situated near Lyeway Farm, on the high ground east of Ropley; another forming part of Tichborne Down, south and south-east of Alresford.

In the Lyeway outlier, small sections are to be seen in the banks of the road running eastward from Ropley Church to Lyeway; but a better exposure than these afford is presented in an adjacent quarry, on the north side of this road, and half-a-mile west-south-west of Lyeway Farm. Here about 30 feet of chalk is shown, containing a good many black and grey flints, partly disposed in definite but impermanent horizontal courses. Small grey flints, of sub-spherical and sub-conical forms, are freely disseminated in the chalk between the courses of larger nodules. Messrs. C. Griffith and R. M. Brydone have given much attention to this section, and many well-preserved fossils thence obtained by them can be seen in the College Museum at Winchester. Among the rarer of the fossils which they collected at Lyeway is an imperfect guard of *Actinocamax* sp.—either *A. quadratus* (Defr.) or *A. granulatus* (de Blainville). Dr. A. W. Rowe and the writer noted, between them, about 20 species belonging to other genera, including,—*Coscinopora quincuncialis* (T. Smith), *Pharetraspongia strahani* Sollas, *Cyphosoma spatuliferum* Forbes, *Echinocorys scutatus* Leske (gibbous), *Pecten* (*Neuthea*) *quinquecostatus* J. Sow. (large), *Spondylus latus* (J. Sowerby).

In the outlier of Tichborne Down the writer saw only one section, namely, that in a field-pit on the south side of the road running south-westward from Bishop's Sutton, at a spot about half-a-mile distant from the village church. The chalk here contains comparatively few small, thick-rinded, grey flints, and has yielded (to Dr. Rowe and the writer) a suite of fossils similar to that obtained in the Lyeway section just described, with the noteworthy additions of,—*Offaster pillula* (Lam.), *Serpula plexus* J. de C. Sow., *Membranipora francgana* (d'Orb.), *Reptomultisparsa rowei* Gregory.

(d.) *Sections near West Meon, Kilmeston, and Cheriton.*—A strip of *Quadratus* Chalk, probably interrupted by valleys of Post-Eocene age towards its western end, follows the high ground to the south of the Itchen Valley, from the neighbourhood of Old Down (south of Privett), by Kilmeston, as far westward, at least, as Gander Down. A smaller outlier occurs on the south side of the Meon Valley, south of West Meon; and another is inferred to exist, on the same side of that valley, south of Westbury House.

An example of *Offaster pillula* (Lam.), ossicles of *Stauranderaster ocellatus* (Forbes), and a specimen of an unnamed species of *Cribritina*,* characteristic of the *Quadratus* Zone, were found in a road-bank exposure, near the contour of 400 feet, 3 furlongs north of Westbury House. The chalk here is about 20 to 30 feet above the base of the zone; and there appears to be room for more than 100 feet of higher beds between this exposure and the ridge-top to the north of it.

A small exposure of beds with *Rhynchonella reedensis* Eth. and *Echinocorys scutatus* Leske (gibbous?), probably in the *Quadratus* Zone, was seen in a lane-bank one-fourth of a mile north-east of West Meon Church.

Soft, blocky chalk, with even courses of thick-rinded flints and a few continuous layers of greyish, marly chalk, is exposed in cuttings 30 to 40 feet deep at West Meon Railway Station, a little less than 3 furlongs south-east of the church. The bedding dips approximately north-eastward, at an angle of 5°. Few fossils were observed: *Hydractinia* sp., *Echinocorys scutatus* Leske (small gibbous), *Salenia* sp., *Serpula gordialis* Schloth., *Onychocolla lamaroki* (v. Hag.), *Rhynchonella reedensis* Eth., *Spondylus spinosus* (J. Sowerby).

Three hundred yards south-east of Brookwood, between West Meon and Bramdean, a quarry shows 14 feet of soft beds with one or two marly seams and small, horned and sub-spherical nodules of grey flint. *Offaster pillula* (Lam.) and *Porosphaera* abound, the other fossils observed including,—*Bourgueticrinus ellipticus* (Miller), *Rhynchonella reedensis* Eth., *Inoceramus cuvieri* J. de C. Sowerby.

A similar chalk, which yielded one poor example of *Echinocorys scutatus* Leske (small gibbous) and a *Bourgueticrinus*-calyx of a *Quadratus*-Zone type, is dug in the fork of the roads a quarter of a mile south of Riversdown Farm, south-east of Kilmeston.

* Mentioned by A. W. Rowe, *Proc. Geol. Assoc.*, vol. xvi, 1900, p. 341. The zoecium somewhat resembles the sole of a hob-nailed boot.

At about the same distance south-south-west of Dean House, Kilmeston, a shallow road-side excavation shows a foot or two of iron-stained chalk with numerous thick-rinded black flints—more like the flints of the Coranguinum Beds than those usually seen in the Zone of *Actinocamax quadratus*. Here the following were obtained.—Of *Polyjerea arbuscula* Hinde, *Echinocorys scutatus* Leske (large, ovate-gibbous), *Hagenovia rostrata* (Forbes), *Serpula plexus* J. de C. Sow., *Cribrilina* sp. (characteristic Quadratus-Zone form, see footnote p. 56.), *Rhynchonella reedensis* Eth., *Inoceramus lamarchi* Park., *Pecten* (*Neitheia*) *quinquecostatus* J. Sow., *Spondylus dutempleanus* d'Orbigny.

Near Cheriton some of the lower beds of the zone, with *Offaster pillula* (Lam.), are exposed in the sides of a disused hollow road which runs parallel with the highway from Bramdean to Winchester, south-west of Hinton Marsh (see above, p. 54); and in a small pit (examined by Dr. Rowe) one-sixth of a mile south of Hockley House. North-westward of Hockley House no exposures of chalk certainly referable to this zone were seen, but the occurrence of outliers in the country between Gander Down and Hampage Wood (south of Avington Park) is not improbable.

(e.) *Sections near Baybridge*.—The Quadratus Chalk seen in the south-western corner of the district appears to be connected with the main mass of this zone in the Hampshire Basin. Fossils are scarce in the few exposures that were noticed by the writer.

A pit by the old kiln at the south-eastern end of Baybridge shows, above the talus, a little soft white chalk with scattered grey flints. A few small sub-gibbous tests of *Echinocorys scutatus* Leske, *Bourguetierinus ellipticus* (Miller), and *Spondylus spinosus* were the only fossils seen.

Chalk of similar appearance is exposed in road-banks east and north-west of the hamlet, and in a pit north-west of Whiteflood Farm, but nothing distinctive of the zone was obtained in any of these places.

List of Fossils from the Upper Cretaceous Beds.

Most of the fossils from which the following list has been compiled were obtained by the writer of this Memoir, and are partly in his possession, partly in the collection of Mr. Ll. Treacher, by whom many of the Bryozoa were determined.

Certain Selbornian and Lower Chalk fossils, which were not observed by the writer in the field, and of which examples are preserved in the Curtis Museum at Alton, are indicated by the letter "C." These were collected mainly by the late Dr. W. Curtis of Alton: the Selbornian forms (determined by Mr. A. J. Jukes-Browne) from Binsted, East Worldham, Selborne, and Kingsley; the Lower Chalk forms from Neatham, Wilsham, Selborne, and Hawkey.

Occurrences noted by Dr. A. W. Rowe are indicated by the letter "R"; those noted by Mr. William Hill, and recorded in the Geological Survey Memoir on "The Cretaceous Rocks of Britain" (vol. i, 1900, p. 106; vol. ii, 1903, p. 61), by the letter "H."

One fossil, marked "W," is in the Museum of Winchester College.

The species entered in the "Lower Selbornian" column were got from the Zones of *Douvilleiceras mammillatum* and *Hoplites interruptus*—nearly all from the latter; those in the "Upper Selbornian" column were obtained, it is believed in all cases, from the Zone of *Schloenbachia rostrata*, which includes the Upper Greensand (Malmstone) and the highest beds of the Gault,

[illegible]

List of Fossils (Upper Cretaceous) —continued.	Selbornian.		Lower Chalk Zones.		Middle Chalk Zones.		Upper Chalk Zones.				
			Schloemb. varians.	Hol. subglobosus.	Rhynch. cuvieri.	Terebratulina lata.	Holaster planus.	M. cortestudinarium.	M. coranguinum.	Marsupites.	Act. quadratus.
	Lower	Upper									
<i>Conulus albogalerus Leske</i>	—	—	—	—	—	—	—	—	×	×	
— <i>subrotundus Mant.</i>	—	—	—	—	×	—	—	—	—	—	
<i>Echinocorys scutatus</i>	—	—	—	—	—	—	—	—	×	—	×
— <i>Leske (ovate)</i>	—	—	—	—	—	—	—	—	×	—	
— (pyramidate)	—	—	—	—	—	—	—	—	—	×	
— (gibbous, 'low- zonal')	—	—	—	—	—	—	×	×	×	—	
— (gibbous, 'high- zonal')	—	—	—	—	—	—	—	—	—	×	×
<i>Echinospatagus murchi- sonianus? Mant.</i>	—	C	—	—	—	—	—	—	—	—	
<i>Hagenovia rostrata</i> (Forbes)...	—	—	—	—	—	—	—	—	—	—	×
<i>Holaster lævis Agass.</i>	—	C	—	—	—	—	×	×	—	—	
— <i>placenta Agass.</i>	—	—	—	—	—	?	×	×	—	—	
— <i>planus (Mant.)</i>	—	—	—	C	—	—	×	×	—	—	
— <i>subglobosus Leske</i>	—	—	—	×	—	—	—	—	—	—	
— <i>trecensis Leym.</i>	—	—	—	—	—	—	—	—	—	—	
<i>Offaster pillula (Lam.)</i>	—	—	—	—	—	—	—	—	—	—	×
<i>Micraster coranguinum</i> (Leske)...	—	—	—	—	—	—	—	—	×	×	×
— <i>cortestudinarium</i> (Goldf.)...	—	—	—	—	—	—	×	×	—	—	
— <i>leskei Desmoul.</i>	—	—	—	—	—	—	×	×	—	—	
— <i>præcursor Rowe</i>	—	—	—	—	—	—	×	×	—	—	
<i>ANNELIDA.</i>											
<i>Serpula ampullacea J. de</i> <i>C. Sow.</i>	—	—	×	×	—	×	×	—	×	×	×
— <i>avita J. de C. Sow.</i>	—	—	—	—	×	—	×	—	×	×	
— <i>cincta Goldf.</i>	—	—	—	—	×	—	×	×	—	—	
— (Vermicularia) con- cava <i>J. Sow.</i>	—	C	—	—	—	—	—	—	—	—	
<i>Serpula cf. fluctuata J. de</i> <i>C. Sow.</i>	—	×	—	—	—	—	—	—	—	—	
— <i>gordialis var. serpen- tinus Schlot.</i>	—	—	—	—	—	—	×	×	—	×	×
— <i>granulata J. de C.</i> <i>Sow.</i>	—	—	—	—	—	—	×	—	×	—	
— <i>ilium Goldf.</i>	—	—	—	—	—	—	—	—	×	—	
— <i>plana S. Woodw.</i>	—	—	—	—	—	—	—	—	—	×	
— <i>plexus J. de C. Sow.</i>	—	—	×	—	—	—	—	—	—	—	×
— <i>turbinella J. de C.</i> <i>Sow.</i>	—	—	—	—	—	—	—	—	—	R	
— <i>spp.</i>	—	×	—	—	—	—	—	—	—	—	
<i>Terebella lewesiensis</i> <i>Davies</i>	—	—	—	×	—	—	—	—	—	—	

List of Fossils (Upper Cretaceous) —continued.	Selbornian.		Lower Chalk Zones.		Middle Chalk Zones.		Upper Chalk Zones.				
	Lower	Upper	Schloenb. varians.	Hol. subglobosus.	Rhynch. cuvieri.	Terebratulina lata.	Holaster planus.	M. cortestudinarium.	M. corangium.	Marsupites.	Act. quadratus.
<i>BRYOZOA.</i>											
<i>Cyclotomata.</i>											
<i>Berenicea canui</i> Greg. ...	—	—	—	—	—	—	—	—	×	—	—
— <i>papillosa</i> (v. Reuss)	—	—	—	—	—	—	—	×	—	—	—
— <i>phlyctænosa</i> v. Reuss	—	—	—	—	—	—	—	×	—	—	—
<i>Clausa globulosa</i> (d' Orb.)	—	—	—	—	—	—	—	—	—	—	—
— <i>francqana</i> (d' Orb.)	—	—	—	—	—	—	×	—	—	×	×
<i>Entalophora echinata</i>	—	—	—	—	—	—	—	—	—	—	—
(Roem.) ...	—	—	—	—	—	—	—	—	—	—	—
— <i>madreporacea</i>	—	—	—	—	—	—	—	—	×	—	—
(Goldf.) ...	—	—	—	—	—	—	—	—	×	—	—
<i>Idmonea alipes</i> Greg. ...	—	—	—	—	—	—	—	—	×	—	—
<i>Meliceritites lonsdalei</i>	—	—	—	—	—	—	—	—	×	—	—
Greg. ...	—	—	—	—	—	—	—	—	×	×	—
<i>Nodelea durobrivensis</i>	—	—	—	—	—	—	—	—	×	—	—
Greg. ...	—	—	—	—	—	—	×	—	×	—	—
<i>Proboscina angustata</i>	—	—	—	—	—	—	—	—	—	—	—
(d' Orb.) ...	—	—	—	—	—	—	×	—	—	—	—
— <i>crassa</i> (Roem.) ...	—	—	—	—	—	—	—	—	×	—	—
— — <i>var. alectodes</i>	—	—	—	—	—	—	—	—	—	—	—
Greg. ...	—	—	—	—	—	—	×	—	—	—	—
— — <i>var. elevata</i>	—	—	—	—	—	—	—	—	—	—	—
Greg. ...	—	—	—	—	—	—	—	—	×	—	—
— <i>radiolitorum</i> (d' Orb.)	—	—	—	—	—	—	—	—	—	×	—
<i>Reptomultisparsa congesta</i> (v. Reuss) ...	—	—	—	—	—	—	—	—	×	×	—
— <i>rowei</i> Greg. ...	—	—	—	—	—	—	—	—	×	×	—
— sp. ...	—	—	—	—	—	—	×	—	—	—	—
<i>Stomatopora granulata</i>	—	—	—	—	—	—	—	×	×	—	×
(M. Edw.) ...	—	—	—	—	—	—	—	×	×	—	—
<i>Truncatula aculeata</i>	—	—	—	—	—	—	—	—	×	—	—
(Mich.) ...	—	—	—	—	—	—	—	—	×	—	—
<i>Cheilostomata.</i>											
<i>Cribrilina simplex</i> (d' Orb.)	—	—	—	—	—	—	—	—	—	—	×
— sp. (A.g. Zone form, see p. 56). ...	—	—	—	—	—	—	—	—	—	—	×
— sp. ...	—	—	—	—	—	—	—	—	—	—	×
<i>Gargantua hippocrepis</i>	—	—	—	—	—	—	—	×	—	—	—
(Goldf.) ...	—	—	—	—	—	—	—	×	—	—	—
<i>Membranipora elliptica</i>	—	—	—	—	—	—	—	×	×	×	×
v. Reuss ...	—	—	—	—	—	—	—	×	×	—	×
— <i>francqana</i> (d' Orb.)	—	—	—	—	—	—	—	—	×	—	×
— <i>inornata</i> (d' Orb.) ...	—	—	—	—	—	—	—	—	×	—	—
— <i>santonensis</i> (d' Orb.)	—	—	—	—	—	—	—	—	×	—	—
— sp. ...	—	—	—	—	×	—	—	—	—	—	—
<i>Micropora confluens</i>	—	—	—	—	—	—	—	—	×	—	—
(v. Reuss) ...	—	—	—	—	—	—	—	—	×	—	—

List of Fossils (Upper Cretaceous) —continued.	Selborman.		Lower Chalk Zones.		Middle Chalk Zones.		Upper Chalk Zones.				
	Lower	Upper	Schloenb. varians.	Hol. subglobosus.	Rhynch. cuvieri.	Terebratulina lata.	Holaster planus.	M. cortestudinarium.	M. corangium.	Marsupites.	Act. quadratus.
<i>Onychocella depressa</i> (v. Hag.) ...	—	—	—	—	—	—	—	—	×	×	×
— <i>lamarecki</i> (v. Hag.) ...	—	—	—	—	—	—	—	—	—	×	×
<i>Vincularia cf. longicella</i> (d'Orb.) ...	—	—	—	—	—	—	—	—	—	—	×
<i>BRACHIOPODA.</i>											
<i>Crania egnabergensis</i> Retz. ...	—	—	—	—	—	—	—	—	×	×	×
— <i>parisiensis</i> Deufr. ...	—	—	—	—	—	—	—	—	×	×	×
<i>Kingena lima</i> (Deufr.) ...	—	—	×	H	—	—	—	—	×	×	×
<i>Lingula subovalis</i> Dav. ...	—	C	—	—	—	—	—	—	—	—	—
<i>Rhynchonella cuvieri</i> d'Orb. ...	—	—	—	—	×	—	×	—	—	—	—
— <i>grasiana</i> d'Orb. ...	—	—	H	H	—	—	×	—	—	—	—
— <i>limbata</i> (Schloth.) ...	—	—	—	—	—	—	×	—	—	—	—
— <i>mantelliana</i> J. de C. Sow. ...	—	—	×	—	—	—	—	—	—	—	—
— <i>martini</i> Mant. ...	—	—	×	—	—	—	×	—	×	×	×
— <i>plicatilis</i> (J. Sow.) ...	—	—	—	—	—	×	×	—	×	×	×
— <i>reedensis</i> Eth. ...	—	—	—	—	—	—	×	—	×	×	×
<i>Terebratula bicipitata</i> J. Sow. ...	—	—	×	—	—	—	×	—	×	×	×
— <i>capillata</i> ? d'Orb. ...	—	C	—	—	—	—	—	—	—	—	—
— <i>carnea</i> J. Sow. ...	—	—	—	—	—	×	×	—	×	×	×
— <i>semiglobosa</i> J. Sow. ...	—	—	×	×	×	×	×	—	×	×	×
<i>Terebratulina lata</i> Eth. ...	—	—	—	—	×	×	×	—	×	×	×
— <i>striata</i> Dav. ...	—	—	×	—	×	×	×	—	×	×	×
<i>Thecidium wetherelli</i> Morris ...	—	—	—	—	—	—	—	—	×	×	—
<i>LAMELLIBRANCHIATA.</i>											
<i>Alectryonia frons</i> (Park.) ...	—	—	C	—	—	—	—	—	—	—	—
<i>Anomia papyracea</i> d'Orb. ...	—	—	—	—	—	×	—	—	—	—	—
<i>Ancellina gryphæoides</i> (J. de C. Sow.) ...	—	C	×	—	—	—	—	—	—	—	—
<i>Cardita cancellata</i> Woods ? — <i>tenuicosta</i> J. de C. Sow. ...	—	—	—	—	—	—	×	—	—	—	—
— spp. ...	×	—	—	—	—	—	—	—	—	—	—
<i>Cucullea glabra</i> Park. ...	—	C	×	×	—	—	—	—	—	—	—
<i>Dimyodon nilssoni</i> (v. Hag.) ...	—	—	×	×	—	—	—	×	×	×	×
<i>Exogyra conica</i> J. de C. Sow. ...	—	×	—	—	—	—	—	—	—	—	—
<i>Grammatodon carinatus</i> (J. Sow.) ...	—	×	×	—	—	—	—	—	—	—	—

List of Fossils (Upper Cretaceous) —continued.	Selbornian.		Lower Chalk Zones.		Middle Chalk Zones.		Upper Chalk Zones.				
	Lower	Upper	Schloenb. varians.	Hol. subglobosus.	Rhynch. cuvieri.	Terebratulina lata.	Holaster planus.	M. cortestudinarium.	M. coranguinum.	Marsupites.	Act. quadratus.
<i>Inoceramus brongniarti</i> J.	—	—	—	—	×	×	×	—	—	—	—
— <i>de C. Sow.</i> ...	—	—	—	—	×	×	×	—	—	—	—
— <i>crippsi</i> Mant. ...	—	—	×	×	—	—	—	—	—	—	—
— <i>concentricus</i> Park. ...	×	×	—	—	—	—	—	—	—	—	—
— <i>cuvieri</i> J. de C. Sow. ...	—	—	—	—	—	—	—	?	×	×	×
— <i>lamareki</i> Park. ...	—	—	—	×	×	—	—	×	—	?	×
— <i>mytiloides</i> Mant. ...	—	—	—	—	×	—	—	—	—	—	—
— <i>sulcatus</i> Park. ...	—	×	—	—	—	—	—	—	—	—	—
— <i>tenuis</i> ? Mant. ...	—	—	×	×	—	—	—	—	—	—	—
— sp. <i>Woods</i> (see p. 44).	—	—	—	—	—	—	×	—	—	—	—
<i>Isoarca agassizi</i> ? Pict.	—	—	—	—	—	—	—	—	—	—	—
— <i>de Roux</i>	—	C	—	—	—	—	—	—	—	—	—
<i>Lima</i> (Mantellum) <i>gaulti</i>	×	×	—	—	—	—	—	—	—	—	—
— <i>Woods</i> ...	—	—	—	—	—	—	—	—	—	—	—
— (Plagiostoma) <i>globosa</i> (J. de C. Sow.) ...	—	×	×	—	—	—	—	—	—	—	—
— <i>hoperi</i> Mant. ...	—	—	—	—	—	×	×	—	—	—	—
<i>Modiola reversa</i> J. de C. Sow. ...	—	C	—	—	—	—	—	—	—	—	—
<i>Nucula pectinata</i> J. Sow. ...	—	H	—	—	—	—	—	—	—	—	—
<i>Ostrea hippopodium</i> Nilss. ...	—	—	×	×	—	×	×	×	×	×	×
— <i>lateralis</i> Nilss. ...	—	—	×	—	—	—	—	—	—	—	×
— — (striate) ...	—	—	—	—	—	—	—	—	—	—	×
— <i>normaniana</i> d'Orb. ...	—	—	—	—	—	—	?	—	×	—	—
— <i>semitrans</i> ? Mant....	—	—	—	—	×	×	×	×	×	×	×
— <i>vesicularis</i> (Lam.)... ..	—	×	×	×	×	×	×	×	×	×	×
— <i>vesiculosa</i> J. Sow. ...	—	C	—	×	—	—	—	—	—	—	—
— <i>wegmanniana</i> d'Orb. ...	—	—	—	—	—	?	—	—	—	×	×
<i>Panopæa mandibula</i> J. Sow. ...	—	—	×	—	—	—	—	—	—	—	—
<i>Pecten</i> (<i>Æquipecten</i>) <i>arlesiensis</i> Woods ...	—	—	×	—	—	—	—	—	—	—	—
— (<i>Æquipecten</i>) <i>asper</i> Lam. ...	—	C	—	—	—	—	—	—	—	—	—
— <i>beaveri</i> J. Sow. ...	—	—	—	×	—	—	—	—	—	—	—
— (<i>Chlamys</i>) <i>cretosus</i> Defr. ...	—	—	×	—	—	—	—	—	×	×	—
— <i>elongatus</i> Lam. ...	—	C	—	H	—	—	—	—	—	—	—
— (<i>Neithea</i>) <i>quadricostatus</i> J. Sow....	—	×	—	—	—	—	—	—	—	—	—
— <i>quinquecostatus</i> J. Sow. ...	×	×	×	×	—	—	×	—	×	—	×
— (<i>Syncyclonema</i>) <i>orbicularis</i> J. Sow....	×	×	×	×	—	—	—	—	—	—	—
<i>Pectunculus sublævis</i> (J. de C. Sow.) ...	—	×	—	—	—	—	—	—	—	—	—

List of Fossils (Upper Cretaceous) —continued.	Selbornian.		Lower Chalk Zones.		Middle Chalk Zones.		Upper Chalk Zones.				
	Lower	Upper	Schloenb. varians.	Hol. subglobosus.	Rhynch. cuvieri.	Terebratulina lata.	Holaster planus.	M. cortestudinarium.	M. coranguinum.	Marsupites.	Act. quadratus.
Scaphites sp. ...	—	—	—	—	—	—	×				
Turrilites costatus <i>Lam.</i>	—	—	—	—	—	—					
— tuberculatus <i>Bosc.</i>	—	—	—	—	—	—					
— scheuchzerianus <i>Bosc.</i>	—	—	—	—	—	—					
Calycoceras naviculare (<i>Mant.</i>) ...	—	—	—	×	—	—					
Douvilleiceras mammilla- tum (<i>Schloth.</i>) ...	—	—	—	—	—	—					
Haploceras cunningtoni (<i>Sharpe</i>) ...	—	—	—	—	—	×					
Hoplites auritus <i>var.</i> catillus <i>J. Sow.</i> ...	—	—	—	—	—	—					
— falcatus (<i>Mant.</i>) ...	—	—	—	—	—	—					
— interruptus (<i>Brug.</i>)	×	—	—	—	—	—					
Mantelliceras mantelli (<i>J.</i> <i>Sow.</i>) ...	—	—	—	×	—	—					
Metacanthoplites rotoma- gensis (<i>Brong.</i>)	—	—	—	×	—	—					
— cenomanensis? (<i>d'Arch.</i>) ...	—	—	—	—	—	×					
Pachydiscus leptophyllus (<i>Sharpe</i>) ...	—	—	—	—	—	—	—	—	×		
Schloenbachia coupei <i>Brong.</i> ...	—	—	—	×	—	—	—	—	—		
— rostrata (<i>J. Sow.</i>) ...	—	—	—	×	—	—	—	—	—		
— varians (<i>J. Sow.</i>) ...	—	—	—	×	—	—	—	—	—		
— varicosus (<i>J. de C.</i> <i>Sow.</i>) ...	—	—	—	×	—	—	—	—	—		
<i>CRUSTACEA.</i>											
Enoplocyrtia sussexiensis? <i>Mant.</i> ...	—	—	—	×	—	—	—	—	—		
Phlyctisoma sp. ...	—	—	—	—	—	—	—	—	—		
Pollicipes glaber <i>Roem.</i> ...	—	—	—	×	—	—	—	—	—	×	×
<i>PISCES.</i>											
Corax falcatus <i>Agass.</i> ...	—	—	—	—	—	—	—	—	—	R	
Enchodus sp. ...	—	—	—	—	—	—	—	—	—		
Lamna appendiculata <i>Agass.</i> ...	—	—	—	—	—	—	—	—	—		
— sp. ...	—	—	—	×	—	—	×	—	—		
Protosphyraena ferox <i>Leidy</i> ...	—	—	—	—	—	—	—	—	—		
Ptychodus polygyrus <i>Agass.</i> ...	—	—	—	—	×	—	—	—	—		

CHAPTER VIII.

READING BEDS. SARSENS.

READING BEDS.

Although remnants of Eocene strata abound in the soil and other superficial accumulations on the Chalk, only one outlier has been detected in the Alresford district, and even this is not strictly *in situ*. The outlier in question—a patch of Reading Beds—underlies the southern part of the village of East Stratton, midway between, and about 11 miles distant from, the main masses of Eocene sediments in the London and Hampshire Basins. Of small size, and occupying a hollow in the Chalk, it makes little or no feature in the landscape, and, but for the existence of brick-yard pits, would be hardly distinguishable from the spread of Clay-with-Flints by which it is partly overlapped. Its preservation is attributable, in some measure, to synclinal folding and the formation of a large solution-hollow, or compound pipe, in the underlying Chalk.

As far as can be seen, the Reading Beds of East Stratton depart in no important particular from the type of the formation presented in sections about Basingstoke and Reading: they consist of mottled loams and sands, and have at their base the usual pebbly, glauconitic, Bottom-bed.

At East Stratton these beds rest on the *Actinocamax quadratus* Zone of the Chalk, and it is not improbable that they formerly did so throughout the area represented on the Alresford Sheet. That this relationship was there maintained over the greater part of the existing Chalk country can hardly be doubted, in view of, (1) the widespread occurrence of Quadratus Chalk in that country at the present day, (2) the rapid attenuation of the succeeding *Belemnitella mucronata* Zone northward from the Hampshire seaboard, and (3) the feeble development of this zone, at the boundary of the Eocene Beds, a few miles to the south of the Alresford district.

North of the Alresford area the Eocene Beds are in contact with the upper part of the Marsupites Zone near Basingstoke, and with the Coranguinum Zone about Reading. The northward overstep of the Upper Cretaceous Beds by the Eocene, which these facts denote, has not been proved in the area of Sheet 300, though the thickness of the strata referable to the *Actinocamax quadratus* Zone appears to be much smaller in the neighbourhood of the Lower Eocene outlier of East Stratton than in certain portions of the high ground between the valleys of the Itchen and the Meon, in the southern part of this district, where the Chalk seems to be wholly denuded of its Eocene cover.

Notes of Exposures.

At the southern end of the brickyard at East Stratton, about a quarter of a mile south-east of the church, a small disused pit showed (in 1909) 4 feet of dull greenish-yellow sandy clay, the lowest visible part of which was said to be only a foot or two above the Chalk.

In the northern part of the yard, at a spot about 200 paces north of the above pit, and at a lower level, the section shown (fig. 11) was as follows :—

	Soil :	dark stony loam	...	...	...	...	Feet.
							to 1
Clay-with-Flints.	{	Bright-red and brown ferruginous clay and loam, full of small flint-pebbles (many green-coated), small angular flints, and unworn flint-nodes	...	...	...	...	seen, to 10
Reading Beds.	{	Brown and greenish-yellow sand and loam, with dull-red mottlings, passing down into grey-brown loam with rusty stains	...	...	...	...	to 10
	{	Bottom-bed : dark-green, glauconitic, calcareous, loamy sand, containing small black and green flint-pebbles, flint-nodes, and a few small pebbles of white quartz ; where least disturbed					$\frac{1}{2}$
Chalk (A.g. Zone).	{	Soft black-speckled chalk with few, almost-rindless flints (see p. 54)	...	...	...	...	seen 6

FIG. 11.—*Junction of Reading Beds and Chalk, East Stratton.*

Vertical Scale (1 inch = 16 feet) exaggerated.



a. Chalk, b. Reading Beds, c. Clay-with-Flints.

The junction with the chalk is very uneven, that rock appearing in the sides of the excavation, and standing up from its floor, in blackened, slickensided pinnacles.

Towards the north-eastern corner of the pit the Chalk disappears, and the overlying loams assume a decided north-eastward dip, which is probably due, in the main, to the subsidence of the beds into a pipe of larger dimensions than any of the hollows of the chalk actually visible ; for the overlying pebbly Clay-with-Flints thickens rapidly in the same direction. The writer was told that brick-loam had been proved for a depth of 25 feet (below the working-level in 1909) in this part of the pit.

A rough gradation noticeable in the heights of the chalk pinnacles, suggested the possible coincidence of their summits with the surface of the plane of erosion on which the Reading Beds were laid down, but the writer saw no sign of the borings that usually traverse the Chalk, for a distance of a foot or so, below that surface.

SARSENS.

As the memorials of vanished strata, not improbably of Eocene age, the rough blocks of stone which are to be seen by the roadsides and elsewhere in many parts of this district have some claim to notice in the present chapter.

These sarsens, greywethers, or bridestones vary much in their character, but the distribution of the several kinds is not entirely

fortuitous. In the northern and central parts of the area covered by the Basingstoke sheet of the one-inch map, sarsens consisting of quartzitic sandstone predominate; but, towards the southern border of that area, blocks of a conglomeratic nature, containing rolled and sub-angular flints and small pebbles of quartz, are not infrequently encountered; and, in the Alresford district, sarsens of this type even outnumber those composed of sandstone alone.

In the country to which the present memoir relates, the proportion and frequency of pudding-stones are at a maximum within an area which includes the villages of Lower Faringdon, Selborne, and East Tisted; and it is there also that the contained flints seem to be most abundant, least worn, and to attain their largest size.

About 50 per cent. of the conglomeratic sarsens known to the writer are masses of closely-packed stones in a scanty matrix of sand, and exhibit little or no sign of bedding. In the more sandy examples the included stones—here mostly well-worn, polished pebbles—are often arranged in definite bands, the intervening sand occasionally possessing a laminated or current-bedded structure.

There appear to be no good grounds for referring any of the local sarsens to the Reading Beds. All that at present can safely be said in regard to their origin and age is, that they are relics of gravelly and sandy deposits which were formed (most probably) under fluvial conditions, and destroyed, during the long interval of time separating the Older Eocene and Older Pleistocene epochs.

Notes of Occurrences.

Brightstone (or Bridestone) Lane, west of Lower Faringdon, runs through and partly over a group of rugged, moss-grown sarsens of the conglomeratic type, situated in the bottom of acombe, a quarter of a mile east of Pies Farm. The biggest block here measures about 6 feet each way. In the hollows of some of the blocks the coarse sandy matrix is only loosely cemented. The included flints, which are mostly subangular, have a weathered appearance; and many of the flint-pebbles possess a dull-white, polished, porcellaneous crust, which, parting more readily from the black or grey core within than from the hardened sand without, gives the weathered surfaces of the sarsens the appearance of being inset with little half-filled bowls. Pebbles of white quartz, up to $\frac{1}{2}$ inch in diameter, are common.

This group seems to be natural.

Many sarsens of the same kind occur by the roadside and in gardens at Faringdon; and many more in similar positions at Selborne and East Tisted. The Wishing Stone, at the top of the well-known Zigzag path up the Chalk escarpment south-west of Selborne, is of this type: other examples, isolated or in small groups, are to be seen at Newton Valence, Alton, Shalden, East Worldham, Greatham, and Ropley.

Flat-sided masses of white and pale-brown sandstone, some with pebbles, some without, were noticed at Bydean Farm near Froxfield, and at the eastern end of Langrish; others, containing seams of small flint and quartz pebbles, stand at the side of the main road at Chilton Candover, and by the lower end of the yew-avenue to the south of that village.

The best-known artificial group of sarsens in the district is that forming the Horse Monument, at the Dean, north-north-east of Brookwood. The stones composing this circle of six tetralithons were collected from places in the southern part of the Alresford district by the late Col. George Greenwood, author of "Rain and Rivers." They are of white and yellow sandstone, containing a variable proportion of flint and quartz pebbles, and sub-angular flints, arranged in bands and thin seams. Some, consisting almost entirely of sand, have the hollowed and mammillated surfaces so often seen in the sandy sarsens of the Berkshire Downs.

With reference to the immediate sources of the stones in this monument, Greenwood writes :—*

"I brought the largest of the sandstones from the top of the clay-capped chalk ridge north of the road between East and West Meon. The next largest flat one I dug out from two feet below the surface of the drift-gravel on the east side of Bramdean. It may, perhaps, have never moved horizontally, or very slightly, but have been gradually and constantly undermined during the excavation of the valley, and so let vertically down."

He states that many of the other blocks were obtained from clay (Clay-with-Flints) at Froxfield; and he mentions the occurrence of a large sandstone, "with perhaps fifteen feet of clay above it," in the road-cutting "on the brow of Filmere [Filmore] Hill, between West Meon and Alton."†

* "Rain and Rivers, or Hutton and Playfair against Lyell and All Comers," 2nd ed., 1866, p. 37.

† *Op cit.*, p. 38.

CHAPTER IX

TECTONIC STRUCTURE AND LAND-FORMS.

STRUCTURE.

The Reading Beds are the youngest of the solid formations recognized in the Alresford district, but there is no reason to doubt that the London Clay, and part, at least, of the Bagshot Series were formerly represented also.

Little or nothing is known concerning the condition of this portion of the country in newer Eocene and Oligocene times. Later, during the Miocene and Pliocene periods, the Cretaceous and Older Tertiary strata, till then, it is believed, but slightly disturbed, were subjected to deforming movements, whereby they were broadly tilted up towards the east, and gently folded along curvilinear axes of east-to-west trend* (fig. 12).

The general uplift on the east—noticed in the Introduction to this Memoir—is connected with the development of the Wealden pericline, which may have been initiated earlier, and completed later, than the east-and-west folds.† Of these latter, three principal anticlines, and as many synclines, are distinguishable within the area here under consideration.

Beginning in the north, there comes, first, the shallow Binsted and Micheldever syncline, whose axis runs through or near Binsted, Wilsham, and Bentworth, to the Candover Valley at or south of Chilton Candover; and continues westward, by East Stratton, and by Micheldever in the area of Sheet 299.

The complementary flexure to the south may be a continuation of either the Thursley or the Hindhead anticline,‡ to the east, and is almost certainly one with the Stockbridge anticline,§ to the west. It enters this district south-east of Lindford, in the Deadwater Valley, but is not well defined in the area of the Lower Greensand and Selbornian outcrops, about Oakhanger and West Worldham. In the Chalk it becomes more distinct, and is readily traceable from Medsted westward, by Armsworth House, Swarraton, and Grange Park. At Swarraton it brings up the middle beds of the Coranguinum Zone of the Chalk to about the level at which the lower beds of the Quadratus Zone occur near Chilton Candover, in the Micheldever syncline to the north (fig. 10, p. 49).

* The age of the system to which these flexures belong is considered by A. Strahan, in 'The Geology of the Isle of Purbeck and Weymouth' (*Mem. Geol. Survey*), 1898, p. 212-214.

† See C. Reid, 'The Pliocene Deposits of Britain' (*Mem. Geol. Survey*), 1890, pp. 3, 69, 70; and M. Bertrand, 'Sur la continuité du phénomène de plissement, &c.', *Bull. Soc. Geol. France*, ser. 3 me, vol. xx, 1892, pp. 134, 135.

‡ See W. Topley, 'Geology of the Weald' (*Mem. Geol. Survey*), 1875, p. 232, and plate ii.

§ See P. J. Martin, 'On the Anticlinal Line of the London and Hampshire Basins,' *Phil. Mag.* ser 4, vol. ii, 1851, p. 132. Other opinions in regard to the eastward continuation of the Stockbridge flexure are expressed by C. Barrois ('Recherches sur le terrain crétacé, &c.', 1876, p. 52), and A. J. Jukes-Browne ('The Clay-with-Flints, &c., *Quart. Journ. Geol. Soc.*, vol. lxii, 1906, p. 152.)

Next to the south comes the more important synclinal flexure of Haslemere,* which, on entering this district from the east, between Linchborough Park and Weaver's Down, expands considerably and assumes, or more clearly exhibits, a complex character. Woolmer Forest, Noar and Wheatham Hills, and the country between Faringdon and Froxfield are within the area of this broad downfold, as is also most of the local catchment of the Itchen and Meon Rivers, between Medsted and Warnford, Northington and Temple Valley.

In the tract thus roughly defined, two secondary synclinal axes, and an intervening anticline can be discerned. One of the former—indistinct in the east, but apparently running from near Woolmer Pond, through Noar Hill, and south of East Tisted—passes through Lyeway, Ropley, and south of Bishop's Sutton to Tichborne Down. Its position near Lyeway is marked by an outlier of the Quadratus Chalk (*see* p. 56), parts of which stand no higher above Ordnance Datum than the Uintacrinus Beds of Swelling Hill and near Bottom Farm, less than a mile respectively to the north and south. West of Tichborne Down this flexure seems to unite with the second and southern minor syncline, owing to the failure of the intervening anticline, mentioned above.

This last flexure appears to strike into the Chalk, from the east or north-east, about The Warren, south-west of Hawkley; and it passes north of Privett and Filmore Hill to West Tisted, and thence, by Bramdean Common, to the neighbourhood of Tichborne Park. As in the case of the other folds, its influence is less apparent in the dips of the bedding in the quarries than in the relations of the Chalk-zone outcrops to the contours of altitude along its course.

In the southern branch of the Haslemere syncline there are signs of a small downfold under Wheatham Hill; but the main axis enters the district south-west of Langrish, and runs westward from the vicinity of Bereleigh House, by Riplington, and south of Westbury House to West Meon, where it takes on a north-west trend which carries it by Bere Farm (south of Brookwood), Kilmeston, Gander Down (northern end) and, probably, through or rather to the south of Hampage Wood, near Avington.

The Haslemere syncline has its southern complement in the nearly-aligned Harting Combe (or Petersfield) and Winchester anticlines—the strongest folds of their kind in the district.

The axis of the Harting Combe fold (*fig.* 1, p. 8), which Topley regarded as the probable continuation of the Crowborough anticline, or "central line of elevation" of the Weald,† runs south-westward from the head of the Combe, by Rake Hanger, Sheet, Red Hill (north of Petersfield), and Aldersnap Farm to Stroud Common; the stronger dips—up to 10° or more—occurring on its north-western side. West of Stroud Common this fold rapidly weakens, and it appears to die out at Langrish, as P. J. Martin long ago remarked.‡

With the failure of the Harting Combe fold, the Winchester anticline comes into existence, or rises from comparative obscurity,

* *See* W. Topley, *op. cit.*, p. 232, and plate ii.

† *Op. cit.*, p. 225. ‡ *Op. cit.*, *Phil. Mag.*, ser. 4, vol. ii, 1851, p. 126, footnote.

about two miles to the south (between Butser and Barrow Hills), in the area of Sheet 316; and its axial line, running westward to west-north-westward, enters the Alresford district about one mile west of Warnford. Its course north-west of this spot is roughly marked by the ridgeway leading from the cross-roads west of Wheely Down to Cheesfoot Head and Temple Valley.* Dips of 15° to 20° were noted on the north-eastern limb of the fold to the east of Warnford.

The axis of the nameless syncline next to the south has not yet been traced, but it probably runs near Baybridge, with about the same bearing as the Winchester fold.

LAND-FORMS.

Although the tectonic features just briefly described, and others not mentioned,† influence the topography, they do so, in a large measure, only indirectly. Anticlinal and synclinal folds alike are marked both by ridges and by valleys, their topographic expression having been determined by particular combinations of variable factors independent of the morphology of the folds themselves.

An illustration of the effect of an alternation of strong and weak strata on the expression of a fold is seen in the south-eastern part of this district, where the crest of the Harting Combe anticline is marked by high ground on the durable Hythe Beds, and by low ground on the yielding Sandgate Beds and Weald Clay.

In the Chalk country, where the differences in the hardness of the exposed beds are much less pronounced, the anticlinal flexures are generally marked by broad rounded ridges, and the synclines by irregular depressions; but, even here, there are not infrequent inversions of relief, as, for example, in the anticlinal depressions of Warnford and Temple Valley, where the comparatively weak underbeds of the Chalk formation are exposed.

The fact that the east-and-west folds have, in the main, a positive expression in the western and south-western parts of the district, where the Cretaceous rocks have been least eroded since the development of these flexures, suggests that a similar relationship between the tectonic and superficial features formerly subsisted in the eastern part of the Alresford area, as well; and that the Itchen, the Alre, and the Micheldever Stream, whose valleys follow synclinal folds, present a type of drainage once prevalent, not only in this area, but also in the Wealden region to the east of it.

In the country of the Lower Greensand and Selbornian rocks, where erosion has been more considerable than in the western part of the district, and the opportunities for stream-adjustment along the outcrops of the softer beds have therefore been greater, synclinal drainage, if it ever existed, has been obliterated; but in the intermediate tract, comprising that portion of the Chalk country draining into the Weald by the Farnham and Alton Branch of the River Wey, its former presence seems to be implied by the convergent tendency of the minor valleys, and by the decline in the

* P. J. Martin (*op. cit.*, p. 130) does not distinguish the course of the Winchester anticline in this district from that of the adjacent minor syncline of Bereleigh House ("Bierly") and Kilmeston.

† There are signs of many small cross-flexures.

altitude of the Wey-Itchen water-parting, in the areas of synclinal structure.*

Although the evolution of the local physiography cannot be fully discussed in the present work, a few points of interest, bearing directly on the subject, may be briefly noted before concluding this chapter.

Temple Valley, in the Chalk downs south of Avington, is a good example of an anticlinal vale in miniature. Its form approaches that of an amphitheatre; its single drainage-outlet, on the north, is notably narrow; its sides are steep, and roughened by small slips of turf and rubble which enable one the better to realize that its development is still in progress. On the west, where a gap in the cincture of Upper Chalk is shown on the map, Temple Valley is barely separated from the larger and deeper vale of Chilcomb, in which it seems destined to be merged.

The Courses of the Meon and the Candover Stream are, in part, strikingly discordant with the adjacent tectonic slopes.

The Meon, which is essentially a synclinal river in its east-and-west reach, between Riplington and West Meon, turns south-westward near Warnford, and crosses the Winchester anticline at a spot where that fold, if not at its strongest, is certainly more pronounced than in most other places.

In this case the discordance may be plausibly ascribed to the capture of the westward-flowing Upper Meon by a more direct South Coast stream (the Lower Meon) rising theretofore in the anticlinal vale south of Warnford. It is inferred that the Lower Meon, in effecting the capture, worked back along the course of one of the Upper Meon's short southern affluents, heading in the same vale.† The broad and shallow gap (between Bere and Wheely Farms) in the ridge north-west of West Meon, and the lower half of thecombe south of Hinton Ampner, appear to mark the route by which the Upper Meon formerly reached the Itchen, near Cheriton.

The southward course of the Candover Stream, across the Micheldever syncline and the Medsted (or Stockbridge) anticline, is less readily to be accounted for. This stream may be the outcome of an encroachment of the Alre-Itchen basin upon that of the Micheldever Stream; but, if so, the encroachment most probably occurred before the Bogmoor-Hill ridge, which roughly marks the Medsted anticline, and which is breached by the Candover near Northington, came into relief.

* The convergence of the minor stream-lines is well marked near East Tisted and Alton.

The intricate drainage of this part of the Chalk country is discussed by H. Bury ('Notes on the River Wey,' *Quart. Journ. Geol. Soc.*, vol. lxiv., 1908, pp. 318-333), who suggests that its main artery—the Leaven or "Tisted Stream"—was marked out on a peneplain of erosion, seemingly as a 'consequent' river. To the present writer, the Leaven drainage appears to be mainly of the 'subsequent' type, and to embody remnants of an older, east-and-west system.

† It should be noted that the little brook which joins the (Upper) Meon from the south, to the west of Westbury House, rises in a smaller anticlinal vale on the Winchester axis, and that the highest source of the Meon is situated in another depression of the same type, to the south of East Meon (see Sheet 316). It is probable, therefore, that part of the drainage of the Warnford vale also once escaped northward. There is, indeed, some evidence of one former northward outlet half-a-mile east of Warnford.

The Candover Stream, evidently long established, probably was marked out on the Tertiary Beds; and the same may be said of most of the chief drainage-lines in the western parts of the Alresford district.

Relations of the Leaven and Caker Streams.—It is worthy of note that the connection of the Leaven with the Caker, south-west of Alton, is of comparatively recent formation, and the result of a capture effected by the latter brook.

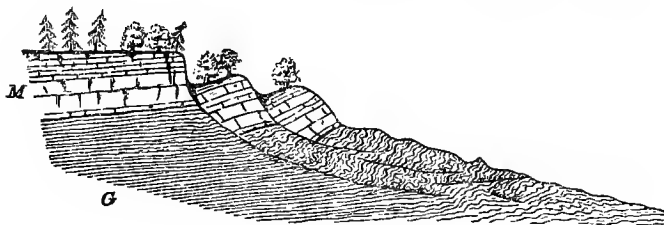
The former course of the Leaven, from Chawton to the River Wey at Alton, is clearly indicated by the short, flat-bottomed valley in which The Butts and New Town are situated; while the recency of the diversion of the stream is attested by the smallness of the difference (about 15 feet) in the altitudes of the old and new channels at the elbow of capture, south-east of the railway junction at The Butts. Owing to this diversion, the Leaven drainage* joins the Wey about a mile farther down, and by a less direct route, than it did before the change took place.

Mr. H. Bury† has lately called attention to other features which imply that the basin of the Caker Stream has developed at the expense of the once-independent Leaven basin.

Landslips.—In the South of England the superficial slopes on the weak, unstable clays of the Gault, in most inland areas, have been reduced to gentle gradients; but here, at the retired western end of the Weald, in the vicinity of a main water-parting, they are still notably steep on the outcrop of the higher beds of this formation, and landslips, involving the exposed edges of these beds, and of the more resistant Malmstone strata above, are consequently of frequent occurrence.

Masses of foundered rock—recognizable in the broken, ridgy state of the ground, and occasionally shown in section in road-cuttings—occur at short intervals all along the foot of the Malmstone escarpment (fig. 13), and are most conspicuous in the space between Wheatham Hill and East Worldham.

FIG. 13.—Section of a Landslip in the Selbornian Beds.



G. Gault, M. Malmstone.

* Little running water is to be seen in the Leaven Valley above Chawton in ordinary seasons. Early in January, 1854, however, G. Greenwood found a "continuous stream along the valley," below Ashen Wood near West Tisted. This was not spring-water, but 'run-off,' due to heavy rain and the melting of snow, while the ground was in a frozen state. See "Rain and Rivers," 2nd ed., 1866, p. 142.

† *Op. cit.*, *Quart. Journ. Geol. Soc.*, vol. lxiv., 1908, p. 333.

The Hawkley landslip, of 1774, which is so graphically described by Gilbert White,* and which, according to that writer, affected about 50 acres of land, seems to have been but a part of a much larger fall.

A slip of fresh appearance occurs below the steep Malmstone scarp north-east of Wheatham Farm, and another, whose main features look older than those of the two just mentioned, extends through the grounds of Le Court, and northward beyond the line of the road running eastward from Bradshott Hall.

The most impressive group of slips, however, is that of Milkwell Wood,† near Candover's Farm (between the Oakhanger Stream and East Worldham), where the broken ground occupies a tract about a mile in length and a quarter of a mile in width.

The knoll called King John's Hill (mapped as an outlier of Upper Greensand), south-east of East Worldham, appears to be part of an older slip, nearly on the same line.

* 'Natural History of Selborne,' *Barrington Letter*, No. 45.

† Noticed by H. W. Bristow, in 'The Geology of Parts of Berkshire and Hampshire' (*Mem. Geol. Survey*), 1862, p. 7.

CHAPTER X.

CLAY-WITH-FLINTS.

The widespread superficial deposit described in the index to Sheet 300 as "Clay-with-Flints and Tertiary Débris overlying Chalk," is a product of the decomposition of the Chalk and the disintegration of the Eocene (and, possibly, later) sediments which formerly covered that formation.

It consists in the main of slightly sandy clay ; dark red-brown to chocolate coloured, and stiff in the lower parts ; lighter in tint and more loamy near the surface, and containing unworn broken flints, entire nodules of flint, and pebbles of the same material and of white quartz, together with blocks of iron-sandstone and sarsens. The relative proportions of these constituents vary much, and, although clay is usually the principal element, arenaceous material, which is seldom or never wanting, is not infrequently present in sufficient quantity to give the deposit a loose and sandy character. The stones, too, are occasionally so abundant as to form a sort of gravel.

Resting on an uneven surface of Chalk, the Clay-with-Flints is subject to rapid changes in thickness ; occurring here in a thin layer hardly distinguishable from soil ; elsewhere filling basin-like hollows and funnel-shaped pipes of unknown depth, and of diameters ranging from a few inches up to 100 yards or more. Such bedding or other structural feature as it displays is usually of the kind that may be reasonably ascribed to the creep or flow of the materials, when in a sodden condition, towards these growing solution-hollows, or down the superficial slopes towards the valleys.

In the distribution of the Clay-with-Flints there is much that seems anomalous. In some areas this drift is so far confined to the tops of the ridges as to convey the impression that it originally was continuous across the spaces now occupied by the intervening valleys ; in others, it behaves like a soil—sweeping from ridge-top to valley-bottom ; while in yet other places, where, perhaps, the form of the ground appears favourable for its preservation, it is almost or wholly wanting.

Again, though it consists so largely of the débris of Lower Eocene strata—and especially of the Reading Beds—it rests indifferently on surfaces which may be four or five feet, or four or five hundred feet, below the Eocene basal plane.

Regarded as a whole, it may be said to be in process of formation at the present day ; for, under the solvent action of rain, the Chalk is slowly yielding up its flints and fine argillaceous matter to swell the bulk of its superficial capping of stony clay and loam. Something more, however, than long-continued solution of the Chalk, and concomitant subsidence of the overlying 'Tertiary débris,' is needed to produce the peculiar features of the Clay-with-Flints. In the blending and spreading out of its constituents, physical processes, differing markedly in degree, if not in kind, from those now in operation, seem to have been involved ; and though it is highly probable that the Clay-with-Flints comprises accumulations of widely diverse ages, there is a good deal to be said in

favour of the theory, ably advocated by Mr. A. J. Jukes-Browne,* that much of this deposit, in its present form, is a result of vigorous soil-cap movement, occurring under sub-arctic conditions, during late Pliocene and early Pleistocene times.

Notes of Exposures.

The principal spreads of Clay-with-Flints lie on the higher part of the Alton Hills; other tracts occur about East Stratton and on the high ground south of the Itchen; and between these there are many small patches in the basins of the Alre and the Candover Stream. Exposures abound, but only a few of the more interesting can be noticed here.

East Stratton.—Angular and unworn flints of small size, associated with flint-pebbles and little pebbles of quartz, are plentiful in the loamy parts of the Clay-with-Flints around this village. A reddish, ferruginous loam, full of such stones (many of the flints being green-coated) overlaps the outlier of Reading Beds and is exposed in the brickyard south-east of the church. The section at the northern end of the yard is described above (p. 67). At the south-eastern end of the yard a pit in a copse shows 10 feet of mottled brown sandy clay with small stones scattered through it, and also arranged in horizontal bands.

The Wields.—A chalk-pit 5 furlongs north-west of Wield Church shows a pipe of mottled red-brown clay and loam containing bunches of little green and black flint-pebbles, doubtless from the Reading Beds. The chalk at the sides of the pipe, for a thickness of 1 to 3 inches, is converted into a hard, brecciate rock of horny appearance, by deposition of tufa, which occurs also in the form of hard mammillated crusts on the joint-surfaces.

Grey and yellow stiff-clay, with few flints, was seen in a drain-trench by the roadside about 300 yards north-west of Wield Church.

A good deal of Reading-Beds material is present in the deposits about Lower Wield.

Bentworth.—Many small openings in red-brown loam and stiff clay, usually with comparatively few flints, are to be seen at and around Bentworth, and to the north-east of Thedden Grange.

Shalden.—Sandy loam with bands of unworn flints is shown in old pits in the southern part of the spread to the south of this village, on the west side of the road to Will Hall. Somewhere in or near these excavations Mr. H. W. Bristow observed "white or french grey sand . . . with subordinate white pipe-clays slightly mottled red," which seemed to fill "a large pot-hole or hollow in the Chalk for a depth of more than twenty feet."†

Chawton and Medsted.—At the brickyard (Phillips's) north of Bushy Leaze Wood, 3 furlongs south-east of Beech Farm, a broad trench, resembling a railway-cutting, affords a good section of part of a large compound pipe, filled with a confused mass of red and brown ferruginous sands, loams, and clays, together with irregular bands and lenticular bodies of pebbly and unworn flints. Obscurely bedded and laminated brown sandy clays, containing seams of white angular flints, appear in the upper part of the excavation near its southern end, where the section is about 20 feet deep.

In the Clay-with-Flints at the brickyard in Chawton Park Wood, Sir Andrew Ramsay observed "lumpy, irregular, stratified masses of white sand, like the shaken wrecks of true Eocene sands of the Woolwich and Reading Series."‡

Brown and bright-red clays and loams, more or less stony, were formerly worked for bricks on the south side of the Alton road just east of Medsted, and in two brickyards (marked on the map) by the high road from Alton to Alresford, south-east and south-west of Medsted Station. In the (Windmill

* 'The Clay-with-Flints; its Origin and Distribution,' *Quart. Journ. Geol. Soc.*, vol. lxii, 1906, pp. 133-161. Its distribution in the area of Sheet 300 is noticed on pp. 155, 156.

† 'Geology of Parts of Berkshire and Hampshire' (*Mem. Geol. Survey*), 1862, p. 29.

‡ Note in 'The Geology of Parts of Berkshire and Hampshire,' 1862, p. 45.

Hill or Four Marks) yard south-east of the station, Mr. Bristow saw some inclusions of white and grey sand (like that near Shalden), containing small, rounded pebbles of white quartz.*

The railway-cutting north-east of Medsted Station shows a good section of flinty clay resting on a deeply-piped surface of Chalk.†

Newton Valence and Selborne.—At Newton a brown sandy clay with many small flints is shown in the banks of the pond near the church. Stiffer clays, with black-spotted flints, appear in road-banks west and north of Shotter's Farm.

At Selborne Common the Chalk is covered with fine-grained mottled loam, of a warm brown tint, and containing comparatively few flint's. A small section is shown in the banks of Wood Pond, a little more than three-quarters of a mile south-west of Selborne Church.

West Tisted and Colemore.—At Lane End, south of West Tisted Common, light-brown loam, with scattered flints and pebbles from the Reading Beds, has been dug to a depth of 20 feet or more, in irregular workings now overgrown.

A chalk-pit 3 furlongs north-north-west of West Tisted Church intersects small pipes filled with red clay in which unbroken flint-nodules, green and black pebbles from the Reading Beds, and nodules of red race are plentiful.

The cuttings on the Meon Valley Railway, between East Tisted and Privett, display good sections of an extremely stony type of Clay-with-Flints, extensively piped into the Chalk.

About 500 yards north-east of Colemore Church road-banks show brown loam with many flint-pebbles.

Some small pipes filled with closely-packed chips and flakes of flint were noted in a chalk pit on the west side of the lane south-west of Prior's Dean Manor Farm. In an adjacent pipe, containing stiff stony clay, brittle flint-pebbles, yielding flakes similar to these, were seen in various stages of disintegration.

Warren Corner and Froxfield.—A pit north-west of Warren Corner shows stiff, black-spotted, red clay, containing very little sand, and probably derived mainly from the Chalk.

Brown stony loam, showing signs of bedding, was seen in a temporary excavation one-fourth of a mile north-north-east of Wheeler's Farm near Froxfield, and many small exposures of the same sort of drift were noticed to the east and west of that village, and about Bydean Farm to the north of it. The occurrence of sarsens in the clay at Froxfield and at Filmore Hill has been mentioned (p. 69).

Lower Borden and West Meon.—Very stony deposits occur on the ridges south-west of Lower Borden. Mr. C. E. Hawkins noted 7 feet of gravelly clay in a pit north-east of Tigwell Farm.

Brown sandy clay with many flint-pebbles shows round the sides of a ponded pit two-thirds of a mile north of Westbury House.

Kilmeston.—Mr. Hawkins saw 5 feet of clayey sand in a pit near the northern corner of Shorley Copse, and 3 feet of flinty loam over fine sand at Shorley Pottery.

* *Op cit.*, p. 29. Samples of this sand and of other material, from the Clay-with-Flints ("Red Clay") in the pits near Medsted and Shalden, are in the Curtis Museum, Alton.

† See C. Barrois, 'Recherches sur le terrain crétacé supérieur de l'Angleterre, &c.' fig. 5, p. 45.

CHAPTER XI.

PLATEAU GRAVEL, VALLEY GRAVEL, AND WASH.

PLATEAU GRAVEL.

The deposits mapped as Plateau Gravel are confined to the north-eastern corner of the area represented on Sheet 300, and comprise three small patches of stony sand and loam, between 370 and 395 feet O.D., on the south-western part of the Gault plateau of Alice Holt.

To judge from surface-indications, the coarse constituents of the gravel here are sub-angular and rounded Chalk-flints, flat pieces of chert and cherty sandstone from the Hythe Beds, and bits of iron-sandstone (carstone) and small quartz-pebbles from the Folkestone Beds or other divisions of the Lower Greensand.

It is probable that these gravelly patches are more or less degraded deposits of some former stream, flowing north-westward from the neighbourhood of Hindhead.* They may be correlated with the Palæolithic deposits of Farnham Common,† between two and three miles to the north-east.

VALLEY GRAVEL.

The majority of the superficial deposits distinguished as "River and Valley Gravel" on the Alresford map occur on the floors of the valleys. In places, however, they occupy well-marked terraces, ranging up to about 50 feet above local stream-level; and there are a few small patches which lie still higher on the valley-sides.

The composition of the Gravel varies with the locality, but Chalk-flints, in various stages of wear, are, as a rule, the most conspicuous of the coarse constituents, throughout the district. In the Chalk country the flints are associated with small quartz-pebbles, sarsens, and iron-sandstones from the Tertiary rocks, and bits of hard iron-ore from the Lower Chalk. Chalk rubble also is a common, and sometimes the chief, constituent, in the low-level deposits. In the eastern part of the district flat-sided pieces of siliceous malmstone are plentiful on the Selbornian Beds; and pieces of carstone, cherty sandstone, and small iron-ore pebbles abound in the area of the Lower Greensand.

The character and distribution of the Valley Gravel imply a larger volume and a greater length for the local rivers in former ages.

The principal developments will be noticed under the headings of, (1) the river basins, and (2) the river valleys, in which they are situated.

Test Basin.—Loamy flint gravel, with many small pebbles of the type found in the Bottom-bed of the Reading Series, occurs in

* See H. Bury, 'Notes on the River Wey,' *Quart. Journ. Geol. Soc.*, vol. lxi, 1908, p. 326.

† See H. W. Monckton and H. A. Mangles, 'Excursion to Farnham,' *Proc. Geol. Assoc.*, vol. xiii, 1893, pp. 74-81.

the head-branches of the Micheldever Valley, near East Stratton. It has been dug in shallow pits half a mile north, and three-quarters of a mile north-west, of Stratton House.

Itchen Basin. 1. Candover Valley.—A gravel similar to that about Stratton occurs in the bottom and on the lower side-slopes of this valley, and of some of its branches.

About 9 feet of coarse to fine gravel, chalky in places, and showing signs of bedding, is shown in a small field-pit near the tumulus, half a mile south-west of Preston Candover Church, and a less thickness is seen in a larger working, with water in its lower parts, by the old grave-yard near the south-western end of Brown Candover.

Loamy gravel is dug in a shallow pit, 10 to 15 feet above the level of the stream, on the east side of the valley, one furlong north of Totford.

2. Alre Valley.—Flint gravel, of varying texture, occurs in all the longer branches of this valley, and has been worked, among other places, at and north of Old Alresford, at North Street near Ropley, and at Ropley Dean, between Ropley and Bishop's Sutton.

West of Alresford a spread of loamy gravel, passing into Clay-with-Flints at its higher edge, covers sloping ground near the railway on the south side of the Alre Valley. A little to the west of the cross-roads at the western end of the town a cutting for a new road showed (in 1908) about 10 feet of red-brown loam and clay, containing many small angular flints arranged in regular bands.

3. Itchen Valley.—A train of gravel follows this valley from its head at Lower Bordean to Itchen Abbas, at the western boundary of the district.

On descending the valley, workings are first met with at a point about half a mile south-east of Privett, and from that point onwards shallow excavations are seen at intervals of a few hundred yards, down to Tichborne. In view of the fact that this valley heads in a deep notch in the crest of the Chalk upland, it was thought that the gravel might afford some indication of the former presence of a stream draining part of the Lower Greensand country to the east, but an examination of the stones in the pits near Privett and elsewhere failed to reveal the presence of any material which could be referred, with certainty, to the Lower Cretaceous or to the Selbornian strata.

Five feet of rather fine, stratified gravel is shown in small pit in the wood south-west of the cross-roads three-fourths of a mile east of West Meon Hut.

At The Dean, north-east of Brookwood, a loose, structureless gravel with many flint-pebbles and some bits of sarsen-stone is dug, to a depth of 5 feet, in a group of irregular workings.

Indistinctly-bedded gravel, containing many small pebbles of brown iron-ore and much chalky matter in pellets, is dug to a depth of 6 feet in a field-pit 3 furlongs north-north-east of Hinton Ampner Church; and a closely similar drift, with some blocks of iron-sandstone, is seen in a shallower excavation about 300 yards south of Vernal Farm, Tichborne.

There are old workings in earthy gravel just south of the confluence of the Alre and the Itchen, to the east of Itchen Stoke. North-east of this village the railway crosses a low terrace.

Small patches of gravelly leam occur on the slopes on the south side of the valley, between Ovington and Avington, up to a height of 150 feet above river-level.

4. Bow Lake Valley.—No superficial deposits are mapped in the south-western part of the district, but it is probable that a little gravel is present in most of the combes which run southward from the ridge of Cheesefoot Head and Lane End Down. Gravel is worked in a shallow pit south of the cross-roads three-fourths of a mile south-east of Whiteflood Farm.

Meon Basin.—Most of the gravel in the upper part of the Meon Valley lies low, and is hidden by the Alluvium. At Warnford,

where it can be seen in the bed of the river, and in cress and drainage-trenches, it contains much chalk rubble.

Arun Basin.—Little gravel is seen in the valley of the Rother and its branches within the present area.

A thin spread of flint and carstone gravel occurs on an ill-defined terrace south-east of Weaver's Down, and patches of loamy flint gravel, with some ironstone and siliceous malm, lie on the gently-rising ground west of Petersfield.

Wey Basin. 1. *Leaven Valley.*—There is a considerable development of gravel in the bottom of this usually-dry branch of the Wey Valley, and it is here that the largest ballast-pits in the district are situated. The gravel probably extends up to the water-parting at Week Green, though it seems not to have been worked above the cross-roads north-west of Hurst Farm.

Pits, from 3 to 7 feet deep, have been dug at this crossing, to the south-east of Basing House, west of Basing Farm, and south-west of the turning to Lane End. In the last of these the gravel is coarse and structureless, and contains many large, unworn, black-stained flints (to 1½ feet in diameter), mixed with pebbly and subangular flints, small pebbles of white quartz, blocks of iron-sandstone, and bits of hard iron-ore (from the Chalk). Prisms of silicified *Inoceramus* are plentiful in the coarse, flint-sand matrix. Between this point and East Tisted there are many other pits; the largest of them being at the road-turning south of Rotherfield Park.

A train of gravel follows the branch combe (Lymington Bottom) which heads at Medsted; and another, containing much chalk-rubble and Lower-Chalk iron-ore near Old Place Farm, extends along the bottom of the wider combe of Prior's Dean, which joins the main valley near Pelham.

Gravel, showing signs of bedding, is dug in a pit some acres in extent to the south-east of Kitcombe House, and in a small excavation at the southern end of Lower Faringdon.* The gravel in this neighbourhood is of finer texture than that higher up the valley.

Near Southfield Farm, about midway between Lower Faringdon and Chawton, a small stream-channel appears on the eastern side of the valley-bottom, and, sloping northwards, at a slightly higher gradient than the surface of the gravel, shortly leaves that deposit in occupation of a low shelf or terrace on its western bank. The terrace is distinct near Chawton House, and sections of the fine-grained, red-brown gravel and loam by which it is covered are shown in a pit near the smithy in Chawton village, and in a disused working, about 10 feet deep, to the south-east of the railway-junction at The Butts.

Below Chawton the water-way of the Leaven turns sharply eastward to the Caker Stream (see p. 75), but the train of gravel holds on its northward course through the short valley of New Town, to the right bank of the Wey in the middle of Alton, when it ends at the top of a degraded bluff whose upper edge is about 25 feet above the level of that river.

2. *Wey Valley.*—The gravelly deposits within and adjacent to the Farnham branch of the Wey Valley, between Alton and Mill Court, occur partly in well-defined terraces, partly in sloping sheets. Saving two small, hill-top patches (which might as well have been mapped as Plateau Gravel), their range in altitude above the river does not appreciably exceed 50 feet; and most of them lie within 40 feet of the level of the stream at its nearest point.

* In the Curtis Museum, Alton, there are two ovate pieces of dark crystalline rock (? diorite), one of which was obtained "from the Drift, [at] Farringdon," the other "from the bottom of the Drift, [at] Alton." They are of fresh appearance, and their presence to the local superficial deposits may be probably ascribed to human agency.

One of the two high-level patches referred to lies on Neatham Down, to the east of Wilsham, at an altitude of nearly 500 feet O.D., and of about 180 feet above the Wey. The other is on Linch Hill, east of Ansty Mill, at a height of about 100 feet above river-level.

On the right bank of the Wey, north-east of Neatham Mill, there are two distinct terraces, standing about 50 feet above the river. Their tops are flat, and from their inner edges there is a sharp descent to the bottom of the valley. The north-eastern terrace, which is crossed by the road from Cuckoo's Corner to Binsted, is backed by gently-rising ground; the other (fig. 14), at Neatham, is parted from the higher ground to the south-west of it by a little valley, but terminates southward at the foot of a bluff forming part of the monticule named Copt Hill.

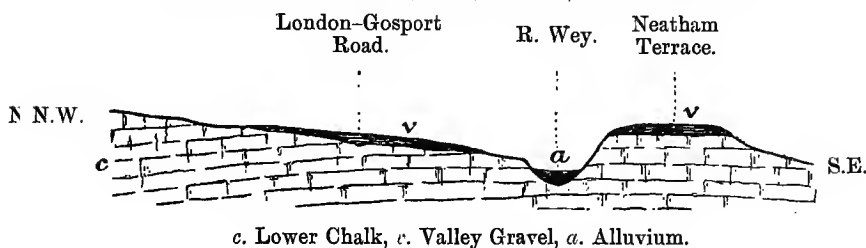
The loamy gravel capping the Neatham terrace is worked for road metal in shallow pits, one of which, situated on the north-west side of the main road across the flat, showed (in 1909) :—

		Feet.
Valley Gravel.	Soil : Dark stony loam, with fragments of grey, Roman pottery* in the lower part	1
	{ Unstratified, ochreous, clayey gravel, consisting chiefly of angular and sub-angular flints, together with small pebbles of flint and quartz ... seen	3½

The Neatham terrace, and that to the north-east of it, may be referred to the same stage as the fine terrace which supports the London and South-Western Railway on the right bank of the Wey at Wrecclesham,† near Farnham.

FIG. 14.—Section of the Wey Valley, Neatham.

Scales : Horiz. 1 inch = $\frac{1}{3}$ mile ; Vertical, 1 inch = 200 feet.



On the left bank of the Wey,—the spreads of gravel along the line of the London and Gosport road most probably were once continuous with the gravel at New Town and Chawton. They show a general decline in level, from the top of the low bluff (Crown Hill) in the midst of Alton, north-eastward, by Ansty and Holybourne, to the boundary of this district, near Mill Court; and much of the ground they occupy stands about 35 to 40 feet above the river. Besides this down-valley slope, however, there is a rather strong transverse, inward slope, which brings the inner margin of the gravel, in places, to within 20 feet of local stream-level, and conspires with the retreating profile of the north-western side of the valley, to weaken the expression of the terrace feature on which these deposits lie (fig. 14).

The gravel here is not well exposed. It is seen in temporary excavations in Alton, and in a pit and railway-cutting west and north-west of Mill Court. Interest attaches to this cutting by reason of the discovery therein of some bones and molar teeth of the mammoth (*Elephas primigenius* Blumenb.).‡

* Some vessels of this ware, found at Neatham, are in the Curtis Museum, Alton.

† See H. W. Monckton and H. A. Mangles, *Proc. Geol. Assoc.*, vol. xiii., 1893, p. 74 and p. 75, fig. 1, c.; also H. Bury, *Quart. Journ. Geol. Soc.*, vol. lxiv., 1908, p. 322.

‡ See H. W. Bristow in 'The Geology of Parts of Berkshire and Hampshire' (*Mem. Geol. Survey*), 1862, p. 47. These remains, found by the late Dr. W. Curtis, are in the Curtis Museum.

The Mill Court terrace, and its fellows about Holybourne and Ansty, belong, in the main, to what the writer has elsewhere* termed the "Bentley Stage." A narrow terrace on the right bank of the Wey, north-east of Alton Paper Mills, also may pertain to this stage; while the gravel-patches, 5 to 10 feet above the stream, on the left bank, west of Wilsham and east of Cuckoo's Corner, are comparable with those by Froyle and Groveland Mills,† lower down the valley.

3. *Lasham Bottom*.‡—There is much more gravel here than is indicated in the geological map. A train of this drift extends along the floor of the valley from the neighbourhood of Herriard§ (Sheet 284) down to Alton, and has been dug for railway ballast and other purposes in many pits, now in most cases disused.

There is an old pit, about 10 feet deep, near the point where the Basingstoke and Alton Light Railway enters the area of Sheet 300, and good exposures are to be seen at Lasham Level Crossing (north of Wadgett's Copse) and at Old Woman's Piece, nearly half a mile north-west of Warren Farm. The gravel is largely of coarse texture, and seldom shows any bedding except in its lowest parts, which are chalky and tufaceous. Small blocks of white and buff sandstone (sarsen) and of iron-sandstone are common.* Fragments of silicified *Inoceramus* are plentiful in the sharp and somewhat loamy sand in which the stones are embedded.

The gravel is not, however, confined to the floor of this valley: it occurs also in little terraces, three of which are well marked.

These occur on the south side of the valley; one between Wadgett's Copse and the turning of the road to Bentworth; the second (and most distinct) at the spot where a patch of gravel is mapped to the west of Will Hall, and the third at and to the east of Wyard's Farm. The first stands about 20 to 25 feet, the second and third about 30 feet, above the valley-bottom: gravel has been dug in all three. These terraces probably belong to the same (Bentley) stage as the terrace north-west of Mill Court, in the Wey Valley, described above (p. 83).

It is noteworthy that some of the combes which open into Lasham Bottom show a decided tendency to 'hang,' their gradients diminishing in the normal manner down to a point near the junction with the main valley, and then somewhat abruptly increasing. This tendency is most pronounced in the case of the combe followed by the lane which runs from Shalden south-westward to Shalden Level Crossing. The upper edge of the step-like feature to which it gives rise is there about 30 feet above the floor of Lasham Bottom. Other instances are afforded by the combes south of Shalden Church and north Lasham Crossing.

Evidently, the deepening of these step-mouthed combes has not kept pace with that of the main valley, but no satisfactory reason for this has occurred to the writer. The normal gradients which the combes in question display in their middle and upper sections seem to have been acquired at a time when the floor of Lasham Bottom stood at about the height marked by the gravel-terraces noticed above.

4. *Oakhanger Valley*.—A small, low-level deposit of flint and carstone gravel is mapped at Free Piece, south-west of Kingsley.

5. *Deadwater Valley*.—East and north-east of Hollywater a sandy gravel, containing much Hythe-Beds chert and sandstone in rolled and sub-angular pieces, caps a small plateau at about 50 feet above the level of the stream.

Low-lying patches of the same character occur at Hollywater, and between Lindford and Deadwater Mill.

* 'Geology of the Country around Basingstoke' (*Mem. Geol. Survey*), 1909, p. 93.

† *Ibid.*, p. 95.

‡ The valley followed by the Basingstoke and Alton Railway, north-west of Alton.

§ See H. J. O. White, *op. cit.*, p. 93.

WASH.

Before passing on to the Alluvium, it will be well briefly to notice certain accumulations, which are not shown on the map, but which have some economic value, and are not without interest to the geological student. These include deposits such as are known as wash, rain-wash, head, trail, rubble-drift, and by other names. They occur as a rule on pronounced slopes, and they not infrequently exhibit a rough bedding approximately parallel with the surface of the ground. Their composition varies from place to place, for they consist in the main of the débris of the rocks which underlie them, or which outcrop on higher ground in their vicinity. Few of these deposits in the area under consideration are likely to be older than the Pleistocene, and some are in course of formation at the present day.

In the Chalk country spreads of chalk and flint rubble, weathering into brown, stony loam, are frequently seen in section in the road-banks; for example, between Warnford and Wheely Down, and north-east of Ashford House, below Stoner Hill. Remains of red deer (*Cervus elaphus* Linn.), found in waste of this kind on the steep southern face of Noar Hill, and at Will Hall, west of Alton, are preserved in the Curtis Museum in that town.

Heavy screes of malmstone rubble, often forming parts of landslips, occur along the foot of the Upper Greensand escarpment, and in some cases are partly exposed in the roadways across that feature; e.g., north-west of Candover's Farm, east of Bradshott Hall, and north-east of Wheatham Hill.

In the lower brickyard at Bradshott, south-east of Selborne, a pit 7 feet deep gives the following section, above the talus:—

									Feet.
Soil, clayey	...	...	...	...	...	...	...	...	1
	2.	Brown clay	...	...	...	...	...	...	to 2½
Wash	...	1.	Stiff, grey, silty clay, containing many flaggy pieces of grey, siliceous malmstone and unworn flints, arranged in regular layers	...	...	...	...	seen 2½	

These deposits are underlain by Gault, which comes to the surface in the higher brickyard (see p. 21), to the west. The structure of bed (1) suggests that it was formed by the superposition of successive washes of mingled stones and mud.

Near their line of outcrop, the Folkestone Beds are commonly covered by washes of clay and other material from the Gault and newer formations—greatly to the improvement of their soils. They have a thick capping of such transported waste at West Lyss, where a pit on the north side of the road to Hurst Gate shows the subjoined section (fig. 15, p. 86):—

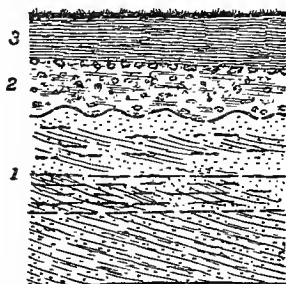
									Feet.
Soil, loamy	...	...	...	...	...	...	...	...	to 1
	3.	Fine, grey and brown loam and loamy sand, with scattered angular flints at the base ...	...	...	...	...	...	...	3 to 7
		passing into							
Wash	...	2.	Light-brown loamy gravel, consisting chiefly of pieces of malmstone, with some bleached angular flints, ironstone, quartz-pebbles, &c.	...	...	...	...	...	4
		resting unevenly on							
Folkestone Beds	...	1.	White and yellow current-bedded sand, with much mica, and many seams of brown and grey clay	...	...	...	...	...	seen 12½

Angular flints are exceptionally abundant in the cultivated soil on the Gault to the west of this pit.

At Sleaford, east of Kingsley, a pit on the north side of the road to Trotsford Farm shows 4 to 15 feet of brown sandy loam, with blocks of carstone, banked against a bluff of Folkestone sand.

FIG. 15.—Section of Gravelly Wash on the Folkestone Beds, West Lyss.

Scale, 1 inch = 16 feet.



1. Folkestone Beds, 2. Gravel,
3. Loam.

West and north-west of Petersfield, the Folkestone Beds in many places have a thick capping of brown and red-brown clayey gravel, composed of angular flints, fragments of siliceous malmstone, phosphatic nodules from the base of the Gault, and other materials. The gravel is well shown in sand-pits west of Aldersnap Farm. The reddish stony soil in the arable land hereabouts resembles that seen in the areas of Clay-with-Flints on the Chalk uplands, and forms a striking contrast to the typical soils of the Folkestone Beds, as seen in Woolmer Forest. A thinner wash of clay with small stones is exposed in brickyard pits at Stroud Common.

On the northern outskirts of Petersfield a more loamy deposit, also containing stones, and capping the Folkestone and Sandgate Beds, has been worked for bricks. Similar drift, showing signs of bedding, is seen on the Sandgates in road-cuttings south-west and north of Sheet.

Washes of sand and loam, containing bleached and reddened angular flints, and pieces of cherty sandstone and of carstone, overspread the Hythe Beds of Sheet, Rake, and Rogate Commons; and obscure the outcrops of the Atherfield Beds and Weald Clay in Harting Combe. Exposures are to be seen at the side of the Petersfield-Guildford road, and in most of the lanes that descend the slope to the north-west of this highway; also in small pits at the brickyard in Harting Combe, and in the banks of the lanes which run southward from Rogate to the Rother by Habin Farm.

Sir Roderick Murchison, who seems to have been the first to call the attention of geologists to the presence of flint detritus on the Lower Greensand in the neighbourhood of Rogate and Rake,* supposed this material to have been transported eastward from the recess in the western margin of the Weald at Langrish;† but Topley's suggestion, that it is "the remains of the Chalk left by the recession of the Chalk escarpment,"‡ appears to be the more probable.

* *Trans. Geol. Soc.*, ser. 2, vol. ii., p. 102.

† *Quart. Journ. Geol. Soc.*, vol. vii., 1851, p. 365.

‡ 'The Geology of the Weald' (Mem. Geol. Survey), 1875, p. 201.

CHAPTER XII.

ALLUVIUM.

The Recent alluvial deposits occur chiefly in narrow strips on the bottoms of the watered valleys, where they form tracts of marsh and of rough meadow-land.

As is the case with the Valley Gravels, their character depends to a large extent on that of the adjacent solid formations. In the Chalk country, fine-grained calcareous loams or marls predominate; in the area of the Lower Greensand, calcareous deposits are seldom seen, their place being taken by sandy loams, often of coarse texture. Peat or peaty loam, and seams of fine gravel occur in both areas, but appear to be commoner in the latter. On the Selbornian Beds, the stream-channels, for the most part, are too narrow and have too quick a fall to hold alluvial deposits that are large enough to be mapped on a scale of one inch to a mile.

The widest spreads of Alluvium are found in the *Alre-Itchen Valley*.

Much of the flood-loam about Old Alresford Pond has accumulated since, and as a result of, the damming of the valley there at the end of the twelfth century. At Ovington and Avington the Alluvium forms a peaty marsh, in many places rising only a few inches above the stream, which traverses it in numerous shallow, braided channels. The deposit is of small thickness, and rests on loose, white gravel of chalk-pebbles and tufa-coated flints.

In the upper part of the Itchen Valley, above Itchen Stoke, many small exposures of brown loam and silty clay, capping a more or less chalky gravel, can be seen in the stream-banks, drains, and watercress trenches at Cheriton and Hinton Marsh. At the southern end of this marsh, at a point a few yards below the spring regarded as the head of the Itchen, the sides of the stream-channel show 2 to 3 feet of mottled brown, stiff, sandy marl in which fragments of Chalk-fossils are plentiful.

In the Candover Valley, dark loam, overlying flint gravel, shows in the banks of the stream near Fob Down Farm, and in other places below Abbotstone.

Meon Valley.—Above West Meon the alluvium here appears to consist merely of brown loam. Below that village it assumes a dark tint, due to the presence of peat. Half a mile north-east of Warnford a channel in the water-meadows shows grey and brown marl with scattered shells, beneath a thin cover of black, peaty earth. In a sample of the marl, which he kindly examined at the writer's request, Mr. A. S. Kennard identified the following species of mollusca—all Recent forms, living in the district at the present day:—

Hygromia hispida (Linn.)
Vallonia excentrica (Sterk)
Agriolimax agrestis (Linn.)
Cochlicopa lubrica (Müll.)
Carychium minimum (Müll.)
Succinea elegans (Risso)
Planorbis leucostoma (Müll.).

Drains and stream-banks north of the bridges at Warnford show peat, about a foot thick, resting partly on grey marl, partly on chalky gravel, which underlies both.

Wey Valley.—Brown loam, and paler, grey-brown marly loam—the latter composed largely of washings of Lower Chalk—are seen in the banks of the Wey at Alton, and in those of the Caker Stream south-east of Wilsham. By the bridge south-east of Cuckoo's Corner the banks of the Wey show thin loam over stratified, sandy, calcareous gravel containing malmstone in sub-angular blocks.

Stiff grey clay with scattered flints thinly covers the Lower Chalk and Upper Greensand in the plain north-east of Faringdon.

In the country drained by the *Oakhanger* and *Deadwater* the Recent stream deposits consist chiefly of brown sandy loams and loamy sands, with seams of fine flint and carstone gravel. Gilbert White mentions* the existence of "many bogs, which formerly abounded with subterraneous trees," in the imperfectly-drained bottoms of Woolmer Forest.

The bed of Woolmer Pond is a dark-brown peaty sand, with scattered bleached flints and small blocks of carstone. An irregular belt of bare, wind-rippled sand marks the zone in which the shore-line oscillates during the winter, and within this belt the bottom is covered with a thick growth of bog-mosses and pennywort.

Rother Valley.—The bulk of the alluvium here is a warm-brown, ferruginous, loamy sand, with but little more of the clayey constituent than is needed to make it bind. Near the mill north-east of Lyss, however, there is a good deal of mud; and the Recent deposits of the brooks which run through Petersfield contain much argillaceous matter, derived from the Gault and clayey wash overlying the Folkestone Beds to the west of the town.

Below Sheet, the Rother has higher and more sharply defined banks than the other streams of the district; and its narrow alluvial flats, standing 6 to 10 feet or more above normal river-level, and frequently bordered by small bluffs, form a succession of low-level terraces. These features are well displayed at Durford, and to the south of Rogate, where the alluvium is notably sandy.

* 'Natural History . . . of Selborne,' *Pennant Letter*, 6; *Barrington Letter*, 59.

CHAPTER XIII.

ECONOMIC GEOLOGY.

SOILS AND LAND DRESSING.

At the western end of Harting Combe the heavy soil of the Weald Clay is naturally tempered with washes of sand and loam from the wasting edges of the Hythe and Atherfield Beds, but much of the ground is marshy, and fit for little save rough pasture, when cleared of undergrowth.

The loose sandy soils of the Atherfield Beds, and of the lower and middle parts of the Hythe Beds, about Rake and Rogate Commons, are covered with heath and woods of mixed fir, oak, beech, birch, sweet-chestnut, and other trees. The light ground on the upper parts of the Hythe Beds, including the calcareous Bargate Beds, is cultivated with that on the lower members of the Sandgate Beds about Lyss and Rogate, but most of the low-lying, moist country on the latter formation is grass-land, with small scattered copses, and rows of alders along the banks of the streams.

Chalk (and, probably, Bargate Stone* also) was formerly burned for lime-manure in small roadside kilns north-west of Rogate and east of Lyss.

Apart from the timbered Inclosures, such as Hogmoor, Brimstone, and Linchborough Park, most of the ground on the Folkestone Beds in the north-eastern part of the district is sandy heath. Gilbert White's phrase, "a hungry, sandy, barren waste," is especially applicable to Weaver's Down. Near the boundary of the Gault between Kingsley and Blackmoor, however, and in an irregular belt of ground following that boundary between Petersfield and Greatham, the sands are covered by loamy soils of varying staple, supporting cereals, and even hops, as in the vicinity of the last-named village.

On the Gault, the stiff clayey soil, often only a few inches thick, is mainly under grass, but bears a good deal of oak and other timber in the Alice Holt Inclosures, and on the slopes west of Oakhanger and north of Petersfield. The calcareous beds of the Gault are used occasionally as alitative manure on sandy soils.

The soils formed by the weathering of the Malmstone (Upper Greensand) are famed for their fertility. They are "suitable for hops, or indeed for any crop requiring a strong soil; . . . falling to a fine powder on exposure to the air, running frequently into the fissures of the firestone rock, filling them with a rich unctuous mould, into which the roots of the hop penetrate 20 feet deep. The malm farmers say that the application of lime once in ten years, 160 bushels to an acre, is of great service, not only in increasing the crop of wheat . . . but also in stiffening the straw—a most valuable quality on strong rich land."†

* See R. I. Murchison, *Trans. Geol. Soc.*, ser. 2, vol. ii, pt. 1, 1826, p. 101.

† J. Wilkinson, 'The Farming of Hampshire,' *Journ. Roy. Agric. Soc.* vol. xxii, 1861; pp. 254, 255.

Gilbert White distinguishes three sorts of malm soil in the parish of Selborne;* the first to be noticed by him occurring in the gardens and small enclosures on the north-eastern side of the village street, and consisting of "warm, forward, crumbling mould, called black malm, which seems highly saturated with vegetable and animal manure"; the second—a "good wheat and clover" soil, found "to the north-west, north and east of the village"—being "a sort of rotten or rubble stone [partly on Lower Chalk], which, when turned up to the frost and rain, moulders to pieces, and becomes manure to itself." The third, found farther "to the north-east, and a step lower, is a kind of white land, neither chalk nor clay, neither fit for pasture nor for the plough, yet kindly for hops, which root deep in the freestone, and have their poles and wood for charcoal growing just at hand. The white soil [on the middle and lower beds of the Malmstone] produces the brightest hops."

At the present time, the principal hop-gardens in this district are situated on the more elevated parts of the Malmstone country about Binsted and the Worldhams. The strongly calcareous soils on the upper beds, near the boundary of the Chalk, are generally cultivated for other crops.

The Lower-Chalk lands vary much in character. The soils of the Varians Zone are superior to those resulting from the disintegration of the less argillaceous Subglobosus Beds, and usually consist of light, crumbling marls which, at their best, are not inferior to the soils of the Malmstone. Indeed, for fertility, Messrs. J. M. Paine and J. T. Way would award the palm to the loose, speckled, greenish soil found in a narrow strip of ground coincident with the outcrop-surface of the Chloritic Marl, at the base of this zone.

The Chloritic Marl, which—as these authors were the first to point out—contains a notable proportion of calcium phosphate, has been dug in many places for manuring all kinds of land. In this district the principal working seems to have been that in Stirvill's Copse, north-west of Wyck (*see above* p. 29). Writing about the year 1847, Messrs. Paine and Way remark that:—

"This quarry has recently been re-opened by the present proprietor, in consequence of his having carted a few loads by way of experiment upon some adjacent pasture-land, where the benefit arising from its application was most perceptible, especially in developing a good herbage of clover. A small quantity was also taken to another part of the estate about a mile distant, and was put upon an arable field; but in this case no advantage accrued. A recent examination of this field demonstrated the cause of the failure by indicating the presence of the identical phosphoric band in the subsoil lying immediately below the spot where the marl was applied. The proprietor also mentioned a circumstance which occurred upwards of 20 years since, when some of the marl from the above pit was carted away to a neighbouring farm. The waggon once broke down, and its contents were thrown upon an adjoining field, and spread very thickly over a small space; the spot was noticed during many successive years on account of the superiority of the crops which grew there; yet, strange to say, this evidence was practically disregarded!"†

The "rank clay, that requires the labour of years to render it mellow," observed by Gilbert White‡ "to the south-west" of the "cart-way" of Selborne, is an accidental feature. Possibly White here refers to the piece of moist pasture-land in the slight hollow between The Wakes and the foot of Selborne Hanger. The soils in Coneycroft Bottom and by Gracious Street, to the north-west of

* 'Natural History . . . of Selborne', *Pennant Letter*, 1, J. Wilkinson (*op. cit.*, p. 255) misinterprets White's remarks on this subject.

† "On the Phosphoric Strata of the Chalk Formation," *Journ. Roy. Agric. Soc.*, vol. ix., 1848, p. 74.

‡ *Loc. cit.* One, at least, of White's commentators has supposed this remark to be an allusion to the Gault.

this, and in the Punfle below the Zigzag, to the south-east, are light to dark grey-brown, strongly calcareous earths, of tolerably good quality, and supporting ordinary garden vegetables, cereals, and hops.

There are other hop-gardens on the Lower Chalk, at Wilsham, Empshott, Hawkley, and elsewhere.

Some of the heaviest land in this formation occurs in the grassy plain drained by the Caker Stream, north-east of Faringdon. Here small openings in the turf show tenacious, grey, stony clay, which resembles Gault soil, and is probably a modified alluvial deposit.

The soils on the Middle and Upper Chalk and overlying Superficial formations are broadly divisible into, (1) red-brown clays and strong loams of the Clay-with-Flints, best developed on the upland ridge-tops; (2) thin chalky mould, occurring on the declivities and driftless summits; (3) brown loams, of varying strength and frequently calcareous, on the gentler slopes in the valleys, and (4) peaty marls and flood-loams, in the watered bottoms.

1. The reddish upland soils are generally cold, hard, and tenacious; seldom dry, yet rarely wet, save when rain is falling. Like most clayey lands, they are greatly improved by marling, and bowl-shaped 'dells,' whence chalk for this purpose is or has been obtained, are to be seen in nearly all the fields on the Clay-with-Flints. There is a good deal of arable land about the Wields, Lye-way, Froxfield, and Privett, but the staple crop is grass. Much of the ground is under heath and timber. Clumps of lean firs, overtopping the oaks and beeches on the clayey ridges, are a conspicuous and somewhat melancholy feature of the landscape in the north-eastern part of the Chalk country.

2. The thin soil on the steep hillsides and open down-lands is often, as the Rev. J. Wilkinson observes, "little more than chalky rubble, or chalk finely comminuted and decomposed by atmospheric action. Residents of much experience," he continues, "without offering any explanation, have remarked that the soil is stronger on the northern than on the southern slopes. The chalk [soil], where weaker, is of a grey or whitey-brown colour, thin, and wanting in cohesion. For instance, when reduced to a fine tilth for turnips, the rain, in a dry season, seems to go through it, and to make no show, although chalk never burns,"*

There are considerable tracts of pasture on ground of this kind in the western part of the district—around Cheesefoot Head and Ithen Stoke Down, and on the slopes of the ridge of Juniper and Bogmoor Hills, to the west of Wield. There and elsewhere, as, for instance, on the Chalk escarpment, the steep places are commonly wooded.

3. The soils on the lower slopes are of divers types, ranging from good, light, marly loam to stiff clay, indistinguishable from that on the ridge-tops. Flints—partly transported from adjacent higher grounds by natural processes, partly brought up from the rubbly sub-soil by the plough—are everywhere abundant. "So thick," writes Wilkinson, "is the flint-drift . . . in some of the dry hollows, that cultivation would seem as little profitable there as on the shingle of a sea-beach. But you are reassured when told of the costly experience of a new-comer, who, having picked up the flints and carted them away, and thereby lost his crops, acknowledged his error by restoring them, as shelter against March winds, protection against summer suns, and warmth against winter frosts."†

On the whole, these valley soils make the best arable land that the Middle and Upper Chalk terrains locally afford, and they are very generally under cultivation. Hops are raised on the sheltered slopes over the Middle Chalk near Alton.

4. Water-meadows and marshes occupy but a small proportion of the Chalk area. Their soils are the alluvial deposits—as a rule somewhat altered superficially by the addition of animal manure, and in places (e.g., the Candover Valley) more profoundly modified by the spade-work involved in the construction and maintenance of systems of irrigation.

* *Op. cit.*, p. 253.

† *Loc. cit.*

BUILDING MATERIAL.

Stone.—The Bargate Stone and the harder cherty sandstones of the Hythe Beds are used for building purposes in the neighbourhood of Lyss, and elsewhere, in the south-eastern part of the district under consideration.

Houses and garden walls, built wholly or partly of the dark red-brown carstone (iron-sandstone, clinker, forest-stone) of the Folkestone Beds, are to be seen at Lyss, Blackmoor, and other places on the borders of Woolmer Forest. This stone is exceedingly durable, and has a pleasing appearance when used in large blocks, and laid in even courses with wide joints. It is still employed locally, both for structural work and for ornamenting mortared joints in the 'nail-head' fashion described by Gilbert White.*

The Selbornian malmstone (malm-rock, firestone, freestone) is quarried now much less than in former times, and many years have elapsed since it ceased to be "in great request for hearth-stones, and the beds of ovens."† "When chiselled smooth," says White, "it makes elegant fronts for houses, equal in colour and grain to the Bath stone, and superior in one respect, that, when seasoned, it does not scale. Decent chimney-pieces are worked from it of much closer and finer grain than Portland; and rooms are floored with it; but it proves rather too soft for this purpose." Houses of this rock have, however, a cold and austere aspect; hardly mitigated by a century's exposure to the weather.

Chalk-flints have been much used in the construction of churches and dwellings of all kinds in the Chalk country, particularly in the northern part of this district. In most cases the stones are roughly faced. There is some good flint-work of the Norfolk type at Warnford, in a wall at the entrance to Warnford Park.

The Chalk itself is seldom quarried for building. Blocks of soft white chalk, from the upper part of the formation, are occasionally met with in old walls, as at Ropley. Farm-yard and barn walls of chalk rubble, faced with plaster and thatched or tiled, are not uncommon, *e.g.*, at Kilmeston and Ropley.

Screened flint-gravel is used for rough-casting in the western part of the district.

Blocks of sarsen (greywethers, bridestones) and of Tertiary iron-sandstone are associated with flint in many of the buildings which consist largely of the last-named material.

Bricks—of red or red-brown tint—have long been the principal building material in this part of the country, and there are few local deposits of a clayey character that have not, at some time, been dug for brick-earth.

Good kiln-bricks, "pavers," and tiles are made in Harting Combe, from mixtures of weathered Weald Clay and fine sands and loams from the Folkestone and Atherfield Beds.

Most of the Gault clays are suitable for the manufacture of bricks and rough earthenware, such as drain-pipes, chimney-pots, and flower-pots. Beds rich in phosphatic nodules are, as far as possible, avoided by the makers, as these concretions spoil the

* *Op. cit.*, Pennant Letter, 4.

† G. White, *lit. cit.*

appearance and reduce the strength of the bricks, when they do not cause them to burst in the burning. The clay is usually mixed with sand from the Folkestone Beds, or, for the cheaper sorts of brick, with small coal and cinders ("breeze"). Stiff grey clays, in the lower part of the Gault, are worked for bricks, field-drains, and other articles in a small yard by Honey Lane, east of Selborne, and in larger factories at Steep Marsh and Stroud Common. Higher beds, of a calcareous character, are worked at Hurst Gate, west of Lyss; and silty clays, near the top of the Gault, in the upper yard at Bradshott, south-east of Selborne.

Bricks are made from loams of the Reading Beds at East Stratton, and from loamy portions of the Clay-with-Flints north of Bushy Leaze, near Chawton. There are old brick-pits in the latter formation near Shalden, Wield, Medsted, Preston Candover, West Tisted, Beauworth, and many other places.

Rough "builders" are or have been made from washes of stony loam, on the Sandgate Beds in the northern suburbs of Petersfield, and on the Gault at Bradshott, Hurst Gate, Steep Marsh, and Stroud Common.

Sand, for building and other purposes, is got from the Folkestone Beds, and, to a less extent, from the other members of the Lower Greensand series. Sharp flint and quartz sand is obtained from the Valley Gravel.

Lime.—The Subglobosus Beds of the Lower Chalk are burned for lime at Wilsham and Langrish. Lime-kilns were noted in other places, on the Chalk and Lower Greensand, but all seemed to have been long disused.

ROAD MATERIAL.

The Hythe chert-beds and Bargate Stone are quarried for road metal. With these and other materials the pebbly sand of the Sandgate Beds is sometimes put down as a binder.

Folkestone-Beds carstone, used about Blackmoor and Greatham, wears well on a good foundation and imparts an agreeable ruddy tinge to the ways. Gilbert White observes* that, "it makes good pavement for paths about houses, never becoming slippery in frost or rain" The same author states that the hard blue parts of the Malmstone "resist rain and frost, and are excellent for pitching of stables, paths, and courts, . . . and for mending of roads. This rag is rugged and stubborn, and will not hew to a smooth face; but is very durable"

Of the local materials suitable for road-mending, flints gathered from the soil on the Chalk, and the valley gravels, are those most commonly in use.

Sarsens are employed as road-side path- and corner-guards.

WATER.

In view of the approaching publication of a special Memoir on the water-supply of Hampshire, a detailed account of the hydrology

* *Op. cit.*, Pennant Letter, 4.

of the Alresford district, more than nineteen-twentieths of which lie within the borders of that county, is deemed to be unnecessary in the present work. All that will be offered here are a few notes relating to local springs and ponds, and to the ground-water levels in the permeable Cretaceous strata.

Lower Greensand.—Numerous small springs of good, soft water issue from the Atherfield Beds and lower Hythe Beds on the sides of Harting Combe, at levels between 250 and 300 feet above Ordnance Datum. The bulk of the rain* absorbed by the Hythe Beds in the high ground about the western end of the Combe, however, is carried northward and southward with the dips from the anticlinal axis; part of it issuing in strong springs (from the Hythe and Sandgate beds) low down on the left side of the Rother Valley, between Mangers (east of Lyss) and Rogate, at altitudes ranging from about 240 feet O.D. near the former place to 140 feet near the latter.

Small springs from the Folkestone sands occur along the line of outcrop of the loamy Sandgate Beds in the Rother and Deadwater Valleys. As in the case of the older strata about Rake and Rogate, the movement of the sub-surface water in the Folkestone Beds is largely dependent on the tectonic structure, and much of the absorbed rain flows westward with the prevailing dip. Some, doubtless, passes away beneath the Upper Cretaceous rocks, but a good deal is discharged in the humid grounds near the boundary of the Gault, between Kingsley and Petersfield, where the loss by evaporation from the ponds and marshy places must be considerable.

At Petersfield, water is reached at small depths (20 to 40 feet from the surface, and under 200 feet O.D.), in the Folkestone and Sandgate Beds. In the rising ground of Stroud Common, west of the town, water stands close to the surface. At the boundary of the Gault, south-west of Stroud Farm, it is reached at depths of 9 to 15 feet in wells and sand-pits. Its level here (approximately 250 O.D.) is said to vary but little with the seasons.

Upper Greensand.—Thanks, in a large measure, to their loosely-jointed condition, the Malmstone beds are highly absorbent, and have very little surface drainage in wet weather.

Springs occur on the forefront of the Malmstone escarpment, but these are mostly of small volume, and the principal discharge takes place in the wide-mouthed ravines which indent that feature, and which, in many cases, extend back to the escarpment of the Chalk. Where the dip is pronounced, water escapes into these ravines from many horizons in the Malmstone. On the plateau of Binsted, where the beds are nearly horizontal, the chief water-yielding zone lies somewhat above the base of the strata mapped as Upper Greensand, and about the horizon at which the Malmstone beds, in a descending sequence, assume an argillaceous character.

* The rainfall is rather high in the western part of this (Alresford) district; 35 to 37·5 inches, according to H. R. Mill (see Rainfall Map in W. Whitaker's 'Water Supply of Hampshire' (*Mem. Geol. Survey*), 1910, plate 1. Gilbert White gives the fall for the year 1782 as 50·26 inches, at Selborne. ('Natural History of Selborne,' *Pennant Letter*, 5).

The wells in the Malmstone country are commonly between 60 and 80 feet deep. In the village of Selborne the wells, "at an average, run to about sixty-three feet, and, when sunk to that depth, seldom fail; but produce a fine limpid water, soft to the taste, and much commended by those who drink the pure element, but which does not lather well with soap."*

A dug well by the "King's Arms," on the south-eastern side of the parish church at Binsted, is said to be 96 feet deep.

The Chalk.—Some of the chief springs in this part of the country flow from the lower division of the Chalk at the main escarpment. Mention may be made of those at Holybourne Church, Ansty Mill (Gaswell's spring), Alton (south-west of the parish church), and Selborne (Coneycroft Bottom, north-west of the village, and Well Head to the south), all in the Wey Basin and mostly below 400 feet O.D.; and Empshott Green, Doscombe Pond (at the head of Batts Brook), and Ashford House, which are in the basin of the Rother (Arun), and mostly above 400 feet O.D. The majority of these are perennial, and nearly all issue from beds well above the base of the Chalk.

Of the two principal sources at Selborne, Gilbert White† remarks that, the spring at the north-western end of the village "frequently fails,"‡ but that the other (Well Head) is "little influenced by drought or wet seasons," and produced 12,960 gallons in 24 hours in September, 1781, "after a severe hot summer, and a preceding dry spring and winter." He adds that, "at this time many of the wells failed, and all the ponds in the vale were dry."§

Springs from the Middle Chalk are comparatively rare. There are a few at Warnford in the Meon Valley, and by Will Hall, west of Alton. Another, of small volume, occasionally runs at Home Farm, 500 yards east of East Tisted Church.

Strong springs from the Upper Chalk abound in the Itchen Valley below Hinton Marsh, and in the lower sections of the Alre and Candover Valleys. The positions of the higher, temporary sources in this part of the district have already been noticed (pp. 4, 5). The writer has no information concerning the periodic fluctuations in the local ground-water level, other than that afforded by these bournes. Probably, a rise and fall of 40 or 50 feet in the water-table is not unusual under the higher grounds. So far as can be judged from the depths of certain wells, the average stand of the ground-water above Ordnance Datum is about 350 feet near Bentworth, 320 feet at East Tisted, 280 feet at West Meon Hut ('George' inn) south-west of Privett, and 250 feet at and around East Stratton. Most of the perennial springs in the Itchen basin, within the area of Sheet 300, are between 140 and 230 feet O.D.

The writer saw no well-marked swallow-holes. It is said that more water escapes from Old Alresford Pond by leakage into such sinks than by normal overflow at the dam. Mr. H. W. Bristow

* G. White, 'Natural History . . . of Selborne,' *Pennant Letter*, 1.

† *Op. cit.*, *Pennant Letter*, 1.

‡ It did so in the summer of 1909.

§ In recent years part of the yield of the Well Head spring has been piped to supply the village, and dedicated to the memory of Gilbert White.

was told, "that sometimes the water drains away so rapidly that the fish have no time to escape, and are left behind on the mud which forms the bed of the pond."*

Superficial Deposits.—The patches of Plateau Gravel on the Gault, in the south-western part of Alice Holt, contain a little water of poor quality.

Water is obtained from the Valley Gravel near the streams in many places.

Ponds play an important part in the economy of the upland hamlets on the Chalk. They are especially numerous in the tracts of Clay-with-Flints, for, although this accumulation is, on the whole, fairly permeable, its stiffer portions can be puddled at little cost. These ponds depend for their existence not wholly on rain or snow, but come under the category of dew-ponds.

"To a thinking mind," says Gilbert White,† "few phenomena are more strange than the state of little ponds on the summits of chalk hills, many of which are never dry in the most trying droughts of summer. . . .

Now, we have many such little round ponds in this [Selborne] district; and one in particular on our sheep-down, three hundred feet above my house; which, though never above three feet deep in the middle, and not more than thirty feet in diameter, and containing perhaps not more than two or three hundred hogsheads of water, yet never is known to fail, though it affords drink for three hundred or four hundred sheep, and for at least twenty head of large cattle besides. This pond,‡ it is true, is overhung with two moderate beeches, that, doubtless, at times, afford it much supply; but then we have others as small, that, without the aid of trees, and in spite of evaporation from sun and wind, and perpetual consumption by cattle, yet constantly maintain a moderate share of water, without overflowing in the wettest seasons, as they would do if supplied by springs."

White conceives that the water, "by its coolness, is enabled to assimilate to itself a large quantity of moisture nightly by condensation; and that the air, when loaded with fogs and vapours, and even with copious dews, can alone advance a considerable and never-failing resource."

* 'The Geology of Parts of Berkshire and Hampshire' (Mem. Geol. Survey), 1862, p. 16. See also T. W. Shore, 'Hampshire Springs and Streams,' in 'Hampshire Independent,' November 27, 1886; and *Proc. Hamps. Field Club*, vol. ii., 1891, p. 33.

G. Greenwood ('River Terraces,' 8° London, 1864, pp. 69, 70) mentions two swallow-holes in the course of the R. Meon near Westbury House.

† *Op. cit.*, Barrington Letter, 29.

‡ Probably that known as Wood Pond, 1,300 yards south-west of Selborne Church, and a little below the crest-line of the ridge which supports Selborne Common and Newton Valence. This pond receives some surface-water from the slope above it. There are bushes on its banks, but now no overhanging trees.

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